The Andhra Agric. J 70 (4): 441-445, 2023
doi :10.61657/aaj.2023.66

Genetic Variability of Oil and Protein Traits of Groundnut lines using Near Infra-red Reflectance Spectroscopy Technology (NIRS)

T Divya Shivani, J V Ramana and D Ramesh
Department of Genetics and Plant Breeding, Agricultural College, ANGRAU, Bapatla, Andhra Pradesh.

ABSTRACT

Peanut protein and oil quality are the important features which decide the market value of the groundnut In the present study 100 advanced breeding lines were phenotyped for traits like protein, oil content using near infrared reflectance spectroscopy (NIRS) at ICRISAT, Patancheru. Analysis of variance showed a significant difference among the lines evaluated. The oil and protein content showed significant negative correlation. Improvement of the crop depends on the magnitude of genetic variability and extent of transmission of character, the cluster analysis divided the 100 peanut varieties into four groups with some differences in the traits between groups. Identification of lines having high oil and less protein content was done and lines with greater variation can be used further in the breeding pipeline.

Keywords: *Arachis hypogaea, Oil content, Protein content and Groundnut*

Groundnut or peanut (*Arachis hypogaea* L.) is the world's sixth leading oil seed crop with a total area of 32.72 million ha, with the production 53.92 million tonnes (FAOSTAT, 2021). India is second largest producer of groundnut and its oil after China followed by USA and Nigeria. Peanut seeds are rich source of energy in the form of oil (48 to 50%), protein (25 to 28%) (Janila *et al.,* 2013), vitamins and several nutritional components (vitamin E, niacin, zinc, iron, calcium, magnesium, phosphorus, riboflavin, thiamine and potassium minerals in the kernels (Dean *et al.,* 2009). Groundnut haulms provide nutritious fodder for livestock contains protein (8-15%), lipids (1-3%), minerals (9-17%) and carbohydrate (38-45%) higher than cereal fodder (Pramanik *et al.,* 2021).

Nutritional quality of groundnut is mainly governed by the proportion of stearic, palmitic, oleic and linoleic acids in the kernels (Deshmukh *et al.,* 2020). Palmitic acid is known to cause an adverse effect on human health and increase the risk of developing cardiovascular diseases (Hu *et al*., 2001). Unlike oleic acid, higher linoleic acid is vulnerable to oxidation causing off-flavors, rancidity, and negatively impacts the oil stability (Patel *et al.,* 2004). Polyunsaturated fatty acids, especially higher linoleic acid, are vulnerable to oxidation, leading to off-flavours. For edible oil extraction, the oil millers prefer groundnuts with high oil content (Janila *et al.,* 2013). For the confectionery industry, it is desirable to have low oil content, high oleic to linoleic ratio and high protein content. To meet these diverse market demands, the breeder needs to develop and screen many breeding populations and select the genotypes that adhere to market criteria for quality parameters.

Sufficient genetic variability exists for quality traits, but the genetic gains for quality parameters are often limited as the breeders have to use laborious and expensive estimation methods. New, rapid and low-cost non-destructive seed quality assay technologies in place of conventional chemical assay approaches like Near Infrared Reflectance Spectroscopy (NIRS) seems the best available option to estimate fatty acid content in peanuts (Lee *et al*., 2016). The present study was the to estimate oil, protein, fatty acids (palmatic, stearic acids) in groundnut kernels using near infrared reflectance spectroscopy (NIRS).

MATERIAL AND METHODS

The experimental material comprised of 100 advanced breeding lines (ABLs) of the groundnut genotypes bred at groundnut breeding program at

ICRISAT, Patancheru, India. Sound mature kernels of the 100 ABLs were analyszed by Near Infrared Reflectance Spectroscopy (NIRS). The content of fatty acidslinoleic, stearic, palmitic, protein content and oil content were determined using the NIRS. Range, mean, genotypic and phenotypic coefficient of variance were computed using standard statistical methods (Burton and Devane, 1953), whereas, heritability in broad sense and genetic advance was estimated by following method adopted by Allard (1960). R studio was used for data analysis such as correlation analysis, principal component analysis and cluster analysis.

RESULTS AND DISCUSSION

The analysis of variance (ANOVA) of the experiment under study was calculated separately for each trait and they showed significant difference at both 1% and 5% level of significance among the genotypes indicating the presence of sufficient variation in the groundnut genotypes.

Fatty acid contents

The stearic acid content in the groundnut varies from 1.83 – 3.31% with a mean value of 2.63%, palmitic acid ranged from 8.23 – 16.56% with a mean value of 11.20%, linoleic acid ranged from 1.71 – 46.06% with a mean value of 13.82%. The phenotypic coefficient of variation (PCV) were marginally higher than genotypic coefficient of variation (GCV) thus indicating that these quality traits are less influenced by environment similar results were observed by Hiremath *et al.,* 2010. High heritability values were recorded in stearic acid (78.93%), palmatic acid (92.33%) and linoleic acid (96.27%) and moderate genetic advance as a per cent of mean (GAM) were recorded in stearic acid (17.14) and high GAM were recorded in palmatic acid (25.60) and linoleic acid (70.40). High heritability coupled with high to moderate genetic advance as per cent mean was indicating the predominance of additive gene action on these fattyacids and are suitable for improvement through selection and similar results were observed by Kaveri *et al.,* 2008.

Protein content

The protein content of the kernels of the ABLs ranged from 19.68 – 34.05 % with a mean of 23.12%. The protein content in the groundnut ranges between 25.0% to 28.0% (Pramanik *et al.,* 2021). Twenty five genotypes (ICGV 16697, ICGV 171012, ICGV 171015, ICGV 181004, ICGV 181032, ICGV 181045, ICGV 181057, ICGV 181086, ICGV 201001, ICGV 201012, ICGV 201013, ICGV 201041, ICGV 201050, ICGV 201064, ICGV 201135, ICGV 201335, ICGR 171039, ICGR 171061, ICGR 171281, ICGR 171299, ICGR 171428, ICGR 171490, ICGR 171520, ICGR 171537, ICGR 171599) had a protein content higher than 28.0%. The phenotypic coefficient of variation (PCV) were marginally higher than genotypic coefficient of variation (GCV) thus indicating that these quality traits are less influenced by environment, similar results were observed by Hiremath *et al.,* 2010. Moderate heritability values (54.72%) and low genetic advance as a per cent of mean (GAM) (8.97) indicated that environmental effect was more than the genotypic effect and due to non-additive gene action selection for further improvement of the trait might not be effective similar, results were observed by Ahmed *et al.,* 2014.

Oil content

The oil content of the 100 ABLs ranged from 41.11 – 58.41% with an average of 49.06% . The oil content in the groundnut ranges from 48 to 50% (Pramanik *et al.,* 2021). Thirty nine genotypes (ICGV 16692, ICGV 171024, ICGV 171025, ICGV 181005, ICGV 181021, ICGV 181023, ICGV 181025, ICGV 181030, ICGV 181037, ICGV 181068, ICGV 181075, ICGV 181083, ICGV 181487, ICGV 191025, ICGV 191028, ICGV 201006, ICGV 201011, ICGV 201030, ICGV 201032, ICGV 201043, ICGV 201085, ICGV 201103, ICGV 201106, ICGV 201125, ICGV 201143, ICGV 201210, ICGV 201290, ICGV 201313, ICGV 201329, ICGV 201349, ICGV 201350, ICGV 201353, ICGV 201372, ICGV 201373, ICGV 96342, ICGR 171472, ICGR 181041, ICGR 181436, GPBD 4) had a oil content higher than 50.0%. The phenotypic coefficient of variation (PCV) were marginally higher than genotypic coefficient of variation (GCV) thus indicating that these quality traits are less influenced by environment similar results were observed by Hiremath *et al.,* 2010. Higher heritability values (78.26%) and high genetic advance as a per cent of mean (GAM) (20.73) indicating the predominance of additive gene action on these fattyacids and are suitable for improvement through selection and similar results were observed by Kaveri *et al.,* 2008.

Correlation Analysis

The oil content showed positive significant correlation with stearic and significant negative correlation with palmatic and linoleic acid. The protein content showed positive signifiant correlation with stearic acid. The fatty acids showed positive significant correlation among each other. The significant negative correlation was observed between oil and protein content suggests that as protein content decreases, there is an increase in oil content. This implies an improvement in oil quality due to the inverse relationship between protein and oil content (Tirkey *et al.,* 2018).

Table 1. Analysis of variance (ANOVA) for quality components in the ABLs of groundnut

Source of variation	df	Stearic Acid	Palmatic Acid	Linoleic Acid	Oil Content	Protein Content
Genotypes (MSS)	99	0.198***	6.473***	27.352***	27.352***	9.041***
Error (MSS)	200	0.0162	0.174	2.318	2.318	1.955

*** p < 0.001; ** p < 0.01; * p < 0.05; ns non-significant

df: degrees of freedom

Table 2. Genetic parameters of different fattyacids, oil and protein content in the ABLs of groundnut

S.No.	Trait	Mean	Range	GCV (%)	PCV (%)	h^2 (%)	GA	GAM (%)
1.	Stearic acid	2.63	1.83 – 3.31	9.36	10.54	78.93	0.45	17.14
2.	Palmatic acid	11.20	8.23 – 16.56	12.93	13.46	92.33	2.86	25.60
3.	Linoleic acid	13.82	1.71 – 46.06	18.30	19.93	96.27	2.55	70.40
4.	Protein Content	23.12	19.68 – 34.05	5.88	7.95	54.72	2.34	8.97
5.	Oil Content	49.06	41.11 – 58.41	5.89	6.66	78.26	1.26	20.73

GCV: Genotypic coefficient of variation, PCV: Phenotypic coefficient of variation, h^2: Heritability, GA: Genetic advance, and GAM: Genetic advance as per cent of mean

Table 3. Correlation for fattyacids, oil and protein content in the ABLs of groundnut

	Stearic Acid	Palmatic Acid	Linoleic Acid	Oil Content	Protein Content
Stearic Acid	**1**				
Palmatic Acid	0.1278 *	**1**			
Linoleic Acid	0.127 *	0.7721 **	**1**		
Oil Content	0.1542 **	-0.2215 **	-0.1774 **	**1**	
Protein Content	0.2484 **	0.082 NS	0.0248 NS	-0.5935 **	**1**

*** p < 0.001 ; ** p < 0.01 ; * p < 0.05; NS non significant.

Table 4. Distribution of 100 genotypes of groundnut in different clusters

Cluster	Number of genotypes	Genotypes included
I	22	ICGV 181045, ICGV 181004, ICGV 201135, ICGV 181057, ICGV 201010, ICGV 171012, ICGV 171015, ICGV 191039, ICGV 171021, ICGV 15083, ICGV 171002, ICGV 171008, ICGV 201352, ICGV 201374, ICGV 181039, ICGV 201320, ICGV 201339, ICGV 201359, ICGV 201358, ICGV 201375, ICGV 201377, ICGV 93468
II	9	ICGR 171599, ICGR 171490, ICGR 171061, ICGR 171537, ICGR 171299, ICGR 171428, ICGR 171281, ICGR 171039, ICGR 171520
III	13	ICGV 181030, ICGV 03043, ICGV 181088, TMV 2, ICGV 181122, ICGV 06189, ICGR 181436, ICGV 181133, ICGV 181086, ICGV 181032, ICGV 201008, ICGV 201329, GPBD 4
IV	56	ICGV 201013, ICGV 201335, ICGV 16697, ICGV 201041, ICGV 201333, ICGV 201012, ICGV 201331, ICGV 201001, ICGV 201009, ICGV 201047, ICGV 201050, ICGV 201350, ICGV 171025, ICGV 16692, ICGV 191025, ICGV 201355, ICGV 16668, ICGV 191033, ICGV 181006, ICGV 201064, ICGV 191028, ICGV 201043, ICGV 201011, ICGV 201032, ICGR 171472, ICGV 181025, ICGV 201106, ICGV 201125, ICGV 181021, ICGV 201373, ICGV 201210, ICGV 201353, ICGV 181075, ICGV 201030, ICGV 201085, ICGV 201372, ICGV 15090, ICGV 181005, ICGV 201290, ICGV 96342, ICGV 181035, ICGV 201024, ICGV 181047, ICGV 201049, ICGV 181487, ICGV 181037, ICGV 201006, ICGV 181083, ICGV 201143, ICGV 181068, ICGR 181041, ICGV 181023, ICGV 201103, ICGV 171024, ICGV 201313, ICGV 201349

Cluster Analysis

Cluster analysis of the 100 ABLs based on the five traits revealed that the genotypes are grouped into 4 different clusters (Fig.1). Cluster I contains 22 genotypes, Cluster II contains 9 genotypes, Cluster III contains 13 geotypes, Cluster IV contained maximum number of lines i.e., 56 lines (Table 4). The variation of the progeny depends largely on the the genetic relationship of the parents, the diverse the parental relationship, the greater the variation and hybrid vigor in progeny. Since lines from different group have larger genetic differences than those from the same group, parental materials should be chosen from different groups to breed offspring possessing better traits and adaptability over their parents.

CONCLUSION

The thirty nine lines were having more oil content and most genotypes were from different clusters leads to more variation and can be used in the different breeding programs and the method NIRS can be used as a gross screening method to quickly evaluate large numbers of lines in short period of time.

LITERATURE CITED

Ahmed HO, Usman A, Lawan Z M and Hasan B L 2014. Genetic variability for oil quality in Groundnut (*Arachis hypogaea* (L.) Walp). In *Proceedings of 38 Annual Conference of Genetic Society of Nigeria*. Vol. 19: 660-664.

Allard R W 1960. Principles of Plant Breeding : John Wiley and Sons, Inc., New York.

Burton G W and Dewane E M 1953. Estimating heritability in tall fescue (*Festuca arundinaceae*) from replicated clonal material. *Agronomy Journal.* 45: 479-481.

Dean L L, Hendrix K W, Holbrook C C and Sanders T H 2009. Content of some

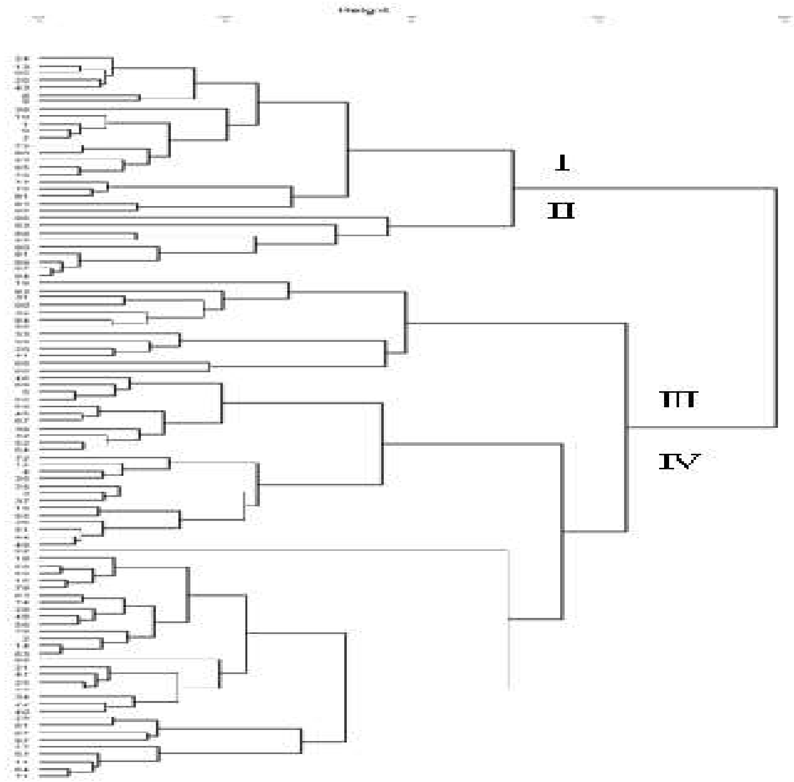

Fig.1. Cluster dendrogram of 100 groundnut advance breeding lines

nutrients in the core of peanut germplasm collection. *Peanut Science*. 36: 104–120.

Deshmukh D B, Marathi B, Sudini H K, Variath M T, Chaudhari S, Manohar S S, Rani C V D, Pandey M K and Pasupuleti J 2020. Combining high oleic acid trait and resistance to late leaf spot and rust diseases in groundnut (*Arachis hypogaea* L.). *Frontiers in Genetics*. 514.

FAOSTAT (2021). FAO Statistical Database. Available online at: http://faostat.fao. org/ (accessed Aug 28, 2022).

Hiremath C P, Nadaf H, Pujer S B and Shinde D G 2010. Induced genetic variability for oil quality traits groundnut (*Arachis hypogaea* L.).

Hu F B, Manson J E and Willett W C 2001. Types of dietary fat and risk of coronary heart disease: a critical review. *Journal of the American college of Nutrition*. 20 (1): 5-19.

Janila P, S N Nigam M K Pandey P Nagesh and R K Varshney 2013. Groundnut improvement: use of genetic and genomic tools. *Frontiers in Plant Science*. 4: 1-16.

Kaveri S B, Nada H L, Vijayakumar A G and Salimath P M 2008. Fatty acid profile of ground nut (*Arachis hypogaea* L.) cultivars. *Crop Improvement*. 35 (1): 61-65.

Lee J M, Pae S B, Choung M G, Lee M H, Kim S U, Oh E Y, Oh K W, Jung C S and Oh I S 2016. Determination of fatty acid composition in peanut seed by near infrared reflectance spectroscopy. *The Korean Journal of Crop Science*. 61 (1): 64-69.

Patel M, Jung S, Moore K, Powell G, Ainsworth C and Abbott A 2004. High-oleate peanut mutants result from a MITE insertion into the *FAD2* gene. *Theoretical and Applied Genetics.*108: 1492-1502.

Pramanik A, Tiwari S, Tripathi M K, Mandloi S and Tomar R S 2021. Identification of groundnut germplasm lines for foliar disease resistance and high oleic traits using SNP and gene-based markers and their morphological characterization. *Legume Research-An International Journal*. 45 (3): 305-310.

Tirkey S K, Ahmad E and Mahto C S 2018. Genetic variability and character association for yield and related attributes in groundnut (*Arachis hypogaea* L.). *Journal of*

Received on 14.07.2023 and Accepted on 12.10.2023