GENETIC DIVERSITY BY LOCAL VARIETY OF PEANUT BASED ON ISOFLAVONES, TOTAL FAT, AND UNSATURATED FATTY ACID CONTENT CHARACTERS

DIVERSITATEA GENETICĂ A UNOR VARIETĂȚI LOCALE DE ARAHIDE, PE BAZA CONȚINUTULUI CARACTERISTIC DE IZOFLAVONE, GRĂSIMI ŞI ACIZI GRAŞI NESATURAȚI

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Abstract. *Genetic diversity of peanut germ plasm is important for plant breeder in making decision regarding selection and method of plant breeding. The data of isoflavones, fats, and unsaturated fatty acid characters were used to estimated genetic diversity. This study was expected to provide information of peanut breeding in the future. The result of this study showed that the genetic diversity of 22 peanut accesions was narrow.*
Keywords*: genetic diversity, accession, peanut, unsaturated fatty acid, isoflavone*

Rezumat*. Diversitatea genetică a germoplasmei arahidelor este importantă pentru amelioratori în ceea ce priveşte metodele de selecţie şi cultivare. Conţinutul de izoflavone, grăsimi şi acizi graşi nesaturaţi a fost folosit pentru a estima diversitatea genetică. Studiul a avut ca scop obţinerea de informaţii referitoare la cultivarea şi ameliorarea arahidelor. Rezultatele studiului arată ca distribuţia diversităţii genetice a celor 22 de cultivare este îngustă.*
Cuvinte cheie*: diversitate genetică, cultivar, arahide, acizi nesaturati graşi, izoflavone.*

INTRODUCTION

Peanut crop is the second most important food crops after soybean. The composition of peanut seeds of economically important are 12-33% carbohydrate, 20-30% protein, and lipid / fat 40-50% (Salisbury and Ross, 1991) as well as mineral deposits such as Calcium, Chloride, Ferro, Magnesium, Phosphorus, Potassium and Sulfur (Sudjadi, 2001). Potential content contained in this placing peanuts as a highly nutritious food crops.

High oil content in peanuts is economically desirable characteristics. Peanut plants known to contain a variety of fatty acid compounds. The presence of fatty acids serve as a source of high energy, so that the peanuts are classified as food crops. The main components include the bean seed protein and fat (Baker, 2002). Fatty acids containing high energy (produce more ATP).

In America and Europe, is known for its peanut oil content containing unsaturated fatty acids (omega 3 and omega 6). In Indonesia, a study of omega 3,

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omega 6 and omega 9 in peanuts has not been done. Research is still oriented cultivation techniques and obtaining high yields (Rashad and Anhar, 2007; Wanget et al., 2002). Because of the need for research on the development of food crops, especially groundnuts very necessary.

In the peanut oil contained compounds which are natural antioxidants tocopherol and effective in inhibiting the oxidation process peanut oil. The tocopherol compounds contained in the unsaturated fatty acids of peanut oil (Ketaren, 1986). The presence of double bonds in the structure of unsaturated fatty acid compounds influence the importance of the resulting compounds. The closer the location of the double bond in the carbon chain structure, such as omega 3 and omega 6, the easier it reacts and the greater nutritional value than other unsaturated fatty acids. Proportionally, saturated fatty acids abundant in animal protein, whereas unsaturated fatty acids found in many plant proteins, including the peanut oil.

Flavonoids and isoflavonoida is one class of secondary metabolites found in many plants, particularly from groups *Leguminaceae*. The content of flavonoids compounds in the plant itself is very low, around 0.25%. These compounds are generally in a state of bound / conjugation with sugar compounds (Snyder and Kwon, 1987). Isoflavone compounds are widely distributed in the plant parts, both in the roots, stems, leaves, and fruit, so that these compounds also unwittingly consumed in the daily diet. In fact, because of its ubiquitous distribution in the plant it is said that when a virtually normal diet without containing flavonoids. It shows that flavonoids are not harmful to the body and even otherwise may provide health benefits.

Studies have shown that isoflavones have antioxidant properties equivalent to the well-known antioxidant vitamin E. The antioxidant power of isoflavones can reduce the long-term risk of cancer by preventing DNA damage. Genistein is an isoflavone among the most powerful antioxidants in soybean, followed by daidzein.

MATERIAL AND METHOD

The research method used was a randomized block design experiment with the treatment of 22 accessions of peanuts in 2 replications, the first planting season and planting season III. The analysis was performed on total fat content, content of Omega-3 Fatty Acids, Fatty Acid Content of Omega-6, Omega Fatty Acid Content-9. Isoflavone content analysis is only done during the growing season I.

The analysis carried out in the Laboratory of Food Crop Post-Harvest in Cimanggu Indonesian Ministry of Agriculture, Bogor in April 2012 and in July 2013.

The material analyzed was a sample of 22 peanut accessions (70 accessions selected from peanuts available based representation of regions in Indonesia peanut spread) with 2 replications, so the number of samples analyzed was 44 samples at each crop growing season (planting season the first and third growing season).

Analysis of laboratory testing performed in the laboratory of the Center for Post-Harvest Food Crops Ministry of Agriculture of Indonesia in Bogor. Tools and materials used laboratory analysis followed the standard operating procedure the international level.

Laboratory and Data Analysis

Laboratory analyzes the content of total fat, polyunsaturated fatty acids (Omega 3, 6, and 9), and isoflavones using samples of peanut seed as much as 100 grams of each accession were observed. Analysis using GC method and Sochlet. Chemicals and reagents used were sulfuric acid 1.25%, 3.25% sodium hydroxide, hexane, sulfuric acid, boric acid 4%, indicator conway, 0.1N hydrochloric acid, sodium hydroxide in methanol, boron triflorida 20 %, saturated sodium chloride and selenium mixture.

The tools used in this analysis is soklet, furnaces, ovens, tube destruction, a set of distillation equipment, electric bath, rotary evaporator, desiccator, filter paper, and other glassware and gas chromatography can separate the components by means of a carrier gas and is recorded as a function of time by the detector (McNair and Bonelli, 1997). Chromatography also provide a short analysis of the sensitivity ppm (Khopkar, 1990) Hitachi brand-263.50 with FID detector. System carrier gas in gas chromatography filter typically contains a molecule of water and other impurities that would be seen in the results recorder (Skoog, 1994).

The observations made by an analysis of the total fat content, the content of unsaturated fatty acids (omega 3, omega 6, omega 9) and isoflavones. Observations were made on samples of peanut seeds that have been dried to a water content of 10-15%.

Data were analyzed statistically by analysis of variance and PCA.

RESULTS AND DISCUSSION

The data results of laboratory analysis of total fat, omega-3, omega-6, omega-9, and isoflavones analyzed variance with randomized block design method. Quadratic mean error value of each character Anova Barlet tested for homogeneity between growing seasons, are in Table 1.

Table 1

Barlet Test Results of 22 Peanut Accession Character Quality

Variance	KTe MT 1	KTe MT 3	Combine	Barlet Test	Criteria
Total Fat	21.30038	35.7779	28.53914	4.555362	inhomogeneous
Omega-3	0.912674	3.977573	2.445124	34.17637	inhomogeneous
Omega-6	19.58171	30.59719	25.08945	3.383465	homogeneous
Omega-9	29.45109	45.58558	37.51834	3.242786	homogeneous

Barlet test results in two cropping seasons on the character quality of the results showed that only two characters are homogeneous. The second character is the homogeneous character of omega-6 and omega-9. Thus the character can be analyzed both combined in the second growing season. The characters are not homogeneous character of omega-3 and total fat content. Both of these characters were analyzed independently of each growing season. In this research, an analysis of the isoflavone content. In the statistical analysis only independent analysis conducted in the first growing season.

Results of laboratory analysis of total fat, unsaturated fatty acids and isoflavones in the two cropping seasons are presented in Table 2.

The results of analysis of diverse quality of the 22 accessions of groundnut is shown in Table 3 Almost all the character quality of the results showed a narrow genetic diversity unless the character content of Omega-3. Character content of Omega-3 has a broad genetic diversity and extensive phenotypic diversity.

Character quality of the results is controlled by many factors, both genetic and environmental interactions, or both. Phenotypic diversity of all the character qualities calculated results is to have a wide variety of categories. This suggests environmental factors strongly influence the quality of the appearance of the character 22 peanut accessions studied.

Table 2

Average content of total fat, unsaturated fatty acids, and isoflavones

Accession	Total Fat	Omega 3	Omega 6	Omega 9	Isoflavons
Atambua	38,3975	2,163	35,03225	35,58225	166,31
Bm 3	36,635	1,5095	28,861	22,0685	288,05
Bm 4	33,73	1,6075	28,283	29,18125	514,01
Gajah	38,04	2,87475	32,6865	33,17375	256,76
Gorontalo A	38,87	2,3735	33,9455	38,21225	420,29
Gorontalo B	38,53	2,206	32,1565	32,734	143,31
Gorontalo C	42,5025	1,923	28,7045	35,812	379,14
Jerapah	41,3325	1,829	33,357	37,18725	247,25
Kanonang Merah	39,03	2,016	27,53075	31,21475	441,53
Kanonang Putih	43,5	2,82425	37,694	38,08025	347,29
Kefa Timor	39,6175	2,0635	33,50725	30,0805	199,89
Kinali Merah	38,465	2,44825	31,13075	32,8115	395,5
Kinali Putih	38,45	1,899	27,06675	36,29775	208,86
Larantuka	35,68	3,320667	40,46933	35,55933	438,62
Madura 1	36,4975	4,064	37,67925	37,15025	152
Siborongborong	39,065	1,3365	30,668	33,9705	152,02
Sima	34,09	2,0845	35,67	36,755	277,81
Soe Timor	35,6325	1,554	30,23525	29,5555	122,98
Sumba Timor	41,2075	4,16175	36,366	32,96675	210,39
Tondegesan Merah	40,265	3,10025	37,243	35,406	272,22
Tondegesan Putih	43,65	1,69	32,4545	35,28175	270,92
Tuban	40,7025	2,35525	31,472	33,17725	342,69

A superior crop varieties should be supported by the potential quality of the results. The quality of peanut yield determined by including the fat content of unsaturated fatty acids and isoflavones content. The results of a study of 22 peanut accessions in two growing seasons, in Table 3, showed a narrow genetic diversity and extensive phenotypic diversity in the character of the total fat content, isoflavones, omega-6, omega-9 and omega-3 (season two). While the character content of Omega-3 in the growing season of the genetic and phenotypic diversity extensive. The results of this study are supported by research over several years of testing at several locations, species strain Valencia peanuts produce oleic acid slightly higher or almost equal to the cultivar New Mexico Valencia C (Burow and Ayers, 2012). Research on the growth of three types of groundnut showed oil content and fatty acids were not significantly different (Raheja et al., 1987), as well as research on four peanut varieties originating from different regions in Pakistan (Akhtar et al., 2005) on the fatty acid composition showed a narrow genetic diversity. Variation of the ratio of high and low grade oleic peanut type in Spanish indicates that factors other than genetics may be involved in determining the ratio of oleic / linoleic (ratio O / L) with appropriate (Lopez et al., 2001). It is claimed that the character quality of peanut plants is strongly influenced by the environment.

Table 3

Diversity of Quality Character of 22 Peanut Accessions

Growing season	Two growing season		One growing season			
			MT 1		MT 2	
Character	σ_g	σ_f	σ_g	σ_f	σ_g	σ_f
Omega-6	-1,79	43,83				
SD	5,27	4,52				
	Narrow	Wide				
Omega-9	-1,91	37,71				
SD	5,24	4,68				
	Narrow	Wide				
Isoflavon			6262,99	18362,06		
SD			4421,22	3630,77		
			Narrow	Wide		
Total Fat			4,62	25,93	-8,47	27.31
SD			6,33	4,50	7,96	2,78
			Narrow	Wide	Narrow	Wide
Omega-3			0,89	1,80	-0,86	3,12
SD			0,44	0,40	0,89	0,33
			Wide	Wide	Narrow	Wide

Analysis of isoflavone content narrow genetic diversity while extensive phenotypic diversity. A similar study by Kirakosyan et al. (2007) on the concentration of isoflavone content in seeds and seedlings on 20 peanut genotypes originating from different geographical sources show a wide diversity. In their

study they also found isoflavone content in groundnut seeds 0.8-fold higher concentration than in the isoflavone content of peanut seeds.

The results of PCA to 5 characters on the quality of the two main components are mapped on a graph as in Figure 1 Biplot Biplot graph shows the distribution of the data character that describes the four main groups of characters that affect the population of 22 peanut accessions were observed. In four distribution groups are groups consisting of two characters, and there are also only consists of a single character. Some characters who are members of the group showed that these characters are-jointly affect changes in a population.

Table 4

Eigenvalue, percentage of variation and percent kumulatif 5 character quality results

PC	Total Eigenvalue	% of Variance	Cumulative %
1	1,897	37,935	37,935
2	1,33	26,6	64,535

Table 4 shows the cumulative percent of the highest value is to PC2. The highest percentage of variance indicated that PC1 character states with high values on PC1 is the most influential character in the diversity of the population of 22 peanut accessions.

Table 5

Component Value Matrix 5 characters at 22 peanut accessions

Characteristics	PC	
	1	2
Omega-6	**0,917**	0,159
Omega-3	**0,888**	
Total Fat	-0,127	**0,923**
Omega-9	0,495	**0,649**
Isoflavon	-0,156	

Table 5 shows the most influential character is the character of Omega-6 and Omega-3 on PC 1 column variation caused by the character of Omega-3 and Omega-6 are jointly affect the diversity of the population of 22 peanut accessions. Biplot diagram (Figure 1) clarify the role of the character of Omega-3 and Omega-6 which together are in quadrant I.

Temperature is the main controller which increase the solubility of oxygen in the water along with the drop in temperature that provides O2 as the recipient of a hydrogen atom essential for the process of unsaturation in the ER so that yield more unsaturated fatty acids. The formation of fatty acids is much faster on the state of the light than in the dark. Plants or parts of plants that received the higher light intensity will result in a higher fatty acid. Ability accession accept a variety of light and temperature cause the expression of diverse fatty acid content.

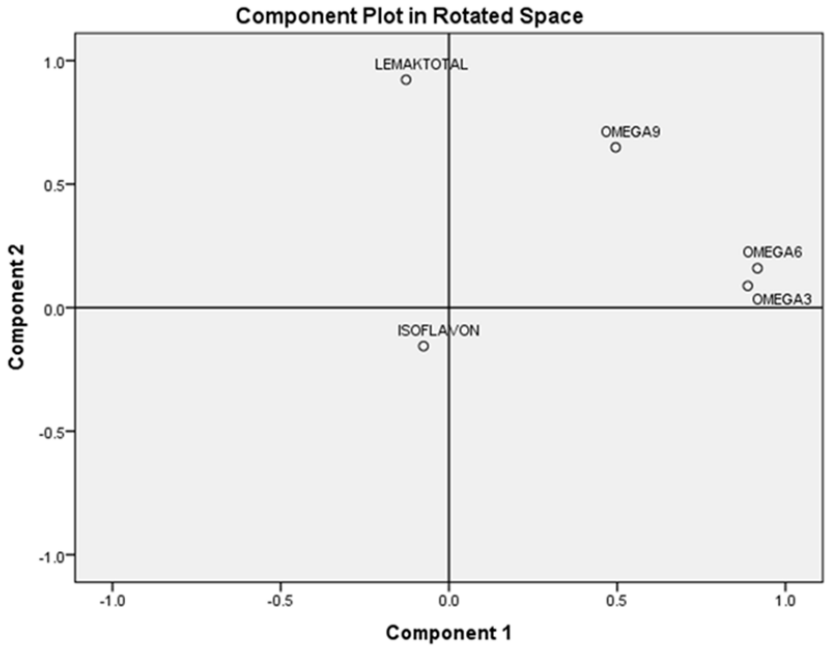

Fig. 1 - Biplot Graphic Pattern Spread the character quality of the 22 accessions of groundnut

The results of PCA for 22 accessions of peanuts on two main components Biplot mapped on a graph as shown in Table 5 and Table 6 and Figure 2 Biplot graph illustrates the distribution of accessions that clustered and distributed almost linear. The results showed that there were 13 accessions most defining quality of the diversity in the population 22 peanut accessions in the study.

Table 6

Eigenvalue, percentage of variation and the percentage of 22 accessions of cumulative groundnut

PC	Total Eigenvalue	% of Variance	Cumulative %
1	11,467	52,124	52,124
2	10,525	47,839	99,963

The data in Table 6 shows that the PC 2 has a higher cumulative percentage values of PC 1, but the higher percetage of variance shows by PC1, 52,124% indicating that accessions having the highest score on PC1 are most influential on the population diversity of 22 accessions of groundnut based character quality results.

Table 7 shows all accessions had values ≥ 0.5 on PC1 and PC2 which states that the accession-accession together create diversity in the population. The

diversity of each accession are displayed on the PC showed extensive phenotypic diversity.

Table 7

Component Value Matrix 22 peanut accessions based on the character quality of the results

Accession	PC		Accession	PC	
	1	2		1	2
Bm 4	0,784	0,621	Tondegesan merah	0,731	0,682
Kanonang merah	0,774	0,633	Tondegesan putih	0,727	0,687
Larantuka	0,77	0,638	Jerapah	0,717	0,697
Kinali merah	0,767	0,642	Kinali putih	0,708	**0,706**
Gorontalo A	0,766	0,643	Soe timor	0,617	**0,786**
Gorontalo C	0,759	0,65	Gorontalo B	0,639	**0,769**
Tuban	0,755	0,656	Siborongborong	0,647	**0,762**
Bm 3	0,753	0,657	Madura	0,648	**0,76**
Kanonang putih	0,747	0,664	Atambua	0,661	**0,75**
Sima	0,738	0,674	Kefa	0,7	**0,714**
Gajah	0,734	0,68	Sumba timor	0,705	**0,709**

The results of the PCA analysis of the population of 22 accessions of groundnut in the form of scores on PC1 and PC2 biplot mapped on a graph as shown in Figure 2.

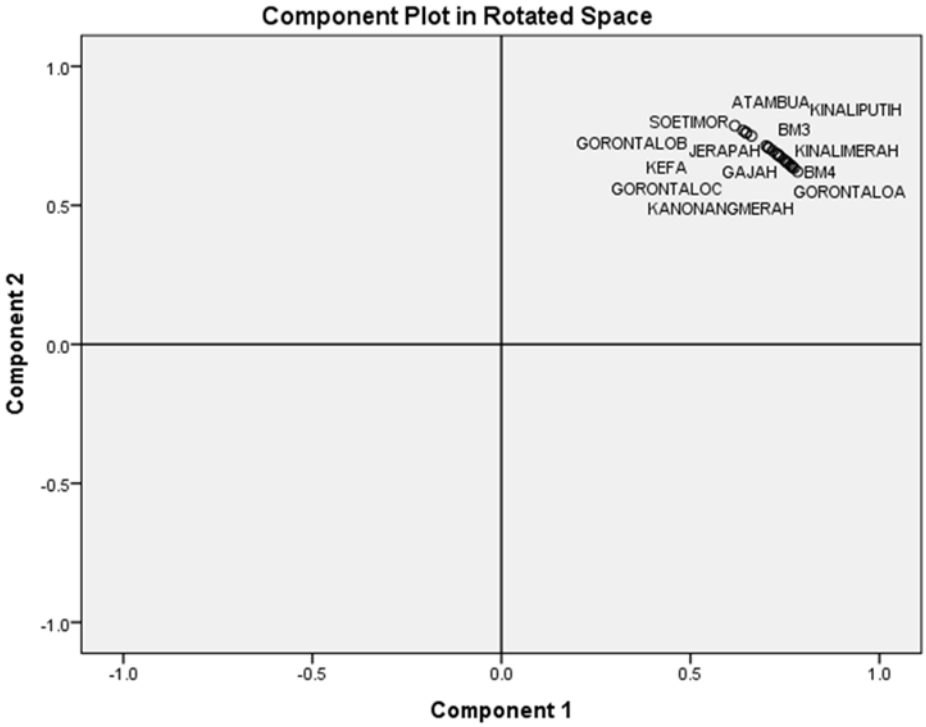

Fig. 2 - Biplot Pattern Chart 22 Spread peanut accessions based on the character quality

Distribution of 22 peanut accessions based on PC1 and PC2 show all accessions form a group on quandran I which showed a narrow genetic diversity of all accessions were observed.

CONCLUSIONS

Phenotypic diversity of all characters analyzed the quality of the results is large, while genetic diversity is narrow, because the metabolism of fats and unsaturated fatty acids and isoflavones are highly influenced by environmental factors so that the selection is based on the diversity of character qualities ineffective results.

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