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Genetic Variability, Heritability and Genetic Advance in Ethiopian Mustard (*Brassica carinata A. Braun*) Accesions for Nutritional Quality Traits

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ABSTRACT

Ethiopian mustard is a traditional African vegetable, previously gathered from the wild for human consumption and the species is a very common leafy vegetable in Ethiopian cuisine and is much liked. This study was conductedto assess genetic variability, heritability and genetic advance among Ethiopian mustard genotypes leaf for nutritional quality trait. 36 Ethiopian mustard genotypes with two replications, a total of 72 sample of leaf were evaluated for 9 nutritional quality traits. The research result revealed the presence of highly significant (P<0.01) differences among Ethiopian mustard genotypes for all traits. The phenotypic and genotypic coefficients ofvariation ranged from 1.83 to 56.73% and 1.26 to 53.96%, respectively. The lowest and highest values were calculated for leaf moisture content and iron content for both GCV and PCV. The heritability values ranged from 48.03 to 96.59 and the genetic advance as percent of mean was estimated in the range between 1.81 and 105.71%.The lowest and highest values of heritability were calculated for moisture content and ash content respectively, whereas the lowest and highest value of genetic advance as percent of mean were calculated for moisture content and iron content respectively. The research results suggested the higher chance of developing varieties for high nutritional quality through selection and/or crossing of genotypes of Ethiopia mustard.

Key words: *Genotypic variation; Nutritional quality; Phenotypic variation; Selection*

Introduction

Ethiopian mustard is a traditional African vegetable, previously gathered from the wild for human consumption and its cultivation is thought to have started about 4000 years B.C. The species is a very common leafy vegetable in Ethiopian cuisine and is much liked. As a leafy vegetable, it is often grown in East and Southern Africa as supplement for ugali (a stiff porridge made from maize or millet flour). Ethiopian mustard widely used as food by the Ethiopians, has recently become object of increasing interest. This is due to its better agronomic performances in areas such as Spain, California and Italy that are characterized by unfavorable environmental conditions for the cultivation of Brassica napus (by far the most common rapeseed cultivated in continental Europe). The agronomic performance and the energetic balance described here confirmed that *Brassica carinata* adapted better and was more productive both in adverse conditions (clay and sandy-type soils and in semi-arid temperate climate) and under low cropping system when compared with Brassica napus [1,2]. The major Ethiopian mustard growing areas are located in Gojam, Arsi, Bale, Eastern Wollega, Central and Southern Shewa. Brassica carinata is found exclusively in Ethiopia,but recently it has been cultivated in different parts of the world. Including Southern Africa (Zambia), West Africa (Sierra Leon and Guinea) and in Asia (India, China, Bangladesh and Indonesia) as a vegetable crop along with other members of the genus. This crop is also extensively cultivated in Eastern Europe and U.S.A. as animal and fish fodder. Nutritional composition is an important trait for *Brassica carinata*, its leaves content was reported to be comparable to *Brassica juncea*. Ethiopian mustard seeds are rich in oil, containing 25-47% depending on cultivar and growing conditions; the protein content is also high, 25-45% and comparable to that of pulses. Ethiopian mustard is reported to have less glucosinolate than *rapa*, *Brassica juncea*, which is one good reason for eating.

Material and Methods

Experimental materials

For this study, 36 genotypes of Ethiopian mustard leaf which were collected from diverse agro ecological locations of Ethiopia and planted in research station field of Holleta agricultural research center. The nutritional content of genotypes was conducted in both Chemistry and Food Science Laboratory of Holetta Agricultural Research Center.

Experimental design and procedures

The field experiments were done using 6 × 6 simple lattice design. Each genotype was planted in a plot size of 1.2 m by 3 m length in each block of replication. The spacing between plants and rows were 10 and 30 cm, respectively. The spacing between plots and blocks was 1 m while 2 m distance was maintained between replications. The leafy vegetable quality estimate moisture content, ash, protein and mineral determinations were conducted from harvested plants along with the succulent. The leaves along with the succulent stems from all the replications for each genotype were used for determination of laboratory quality parameters. The composite samples of plants leave along with the succulent stems washed with clean water and made ready for determination of moisture content while the remaining sample drained and powder made from it was used for determination of protein, ash and mineral content in laboratory [3].

Data Collection for nutritional traits

The data related to nutritional quality traits (moisture content, dry matter content, ash, protein, and minerals) were collected from laboratory analyses which was determined as per the internationally established procedures official methods of analysis of AOAC (Associations of Official Analytical Chemists) (AOAC, 2000) for each trait. These data are listed below with the descriptions and measurements. Moisture and dry matter content of edible parts. Five gram samples were accurately weighed into pre-labeled, pre-weighed dishes and were dried at 105°C for 3 hour to constant weight. Transfer with partially covered lid to desiccator to cool. Dried samples/dishes were weighed.

Protein content

Protein content was started by digesting about two gram of sample in a Kjeldahl flask, Ten gram of kjeldhal tablet was added to the sample inside the flask. Twenty milliliter of 98% concentrated sulphuric acid was mixed with the sample. The sample digestion was started by connecting the kjeldhal flasks with the digestion rock. The digestion was completed when the brown color of the sample was completely disappeared. After digestion water (250 ml) and sodium hydroxide (45%) was added, then distilled into 25 ml of excess boric acid containing 0.5 ml of screened indicator. Finally, the distillate was titrated with 0.1N hydrochloric acid to the red end point to get % of nitrogen [4].

Mineral content analysis

For mineral analysis 0.5 g of powdered dried sample of Ethiopian mustard powdered leaf was taken in a crucible and converted to ash in the muffle furnace at 550°C for 8 h. After cooling in a desiccator, 2.5 ml of HCL was added carefully letting acid rinse the upper portion of crucibles, rinse with water, then filtered quantitively in to 100 ml volume of flask, dilute and mix it. pipette 10ml aliquot in to 25 ml volume of flask and add and mix solution. Let stand measure absorbance of samples with standards and blank solution. The solution was used for determinationof Ca, Fe, Zn, Mg, K through the atomic absorption spectrometry and Five-point calibration was done for each metalwith certified AAS standards of 1000 mg/L.

Data analysis

***Analysis of variance*:** The quantitative data were subjected to analysis of variance (ANOVA). The ANOVA was computed with SAS statistical software (9.2) (SAS, 2008). The traits that exhibited significant mean squares in general ANOVA were done further subjected to genetic analyses. Phenotypic and genotypic variance and coefficient of variation, heritability, and genetic advance were computed using the excel Microsoft program.

Results and Discussion

Analysis of variance for leaf quality traits

The analysis of variance computed for 9 leaf quality traits showed the presence of significant difference among 36 Ethiopian mustard genotypes for all traits (Table 1). The analysis of variance conducted for simple lattice design in which the sample directly came from field, since the samples leaves used to determine the quality traits were taken from each plot (36 plots) of each (2) replication of lattice design a total of 72 samples. The presence of significant variations among genotypes for leafy vegetable quality related traits and mineral contents might give good opportunity for breeders to select genotypes of varied quality and quality related traits. In related crop Singh observed highly significant difference for mineral composition such as calcium, potassium, iron and zinc among 71 genotypes of cabbage (*Brassica oleracea var.* Capitata L.). Buhroy observed highly significant difference for nutritional quality parameters in vegetable Amaranthus protein, iron, nitrate and crude fiber contents in the leaves. Sarker observed highly significant variation in 43 vegetable leafy amaranths accessions for leaf mineral content such as potassium, calcium, magnesium and protein contents. Hence the ANOVA results of the present study for various nutritional quality traits was in agreement with earlier reports depicting the presence of significant variability among Ethiopian mustard genotypes collected from different parts of the country. Therefore, the possibility of improving this crop for quality trait is high [5-7].

Table 1: Mean squares from analysis of variance for 9 quality related traits of 36 Ethiopian mustard genotypes evaluated at Holleta during the 2017/18 main season.

Traits	**Rep**	**Blocks/Rep**	**Genotype**	**Error**		
				RCBD	**Intra-block**	**CV (%)**
Moisture content (%)	1.79	0.95	3.39*	1.12	1.19	1.31
Dry matter content (%)	1.79	0.95	3.39*	1.12	1.19	6.38
Protein content (%)	0.75	1.9	4.59**	0.99	0.64	7.04
Ash content (%)	0.06	0.27	6.91**	0.16	0.12	2.7
Magnesium (mg/100 g)	0.11	17.48	110.12**	16.4	15.97	7.82
Potassium (mg/100 g)	345.77	244.53	8924.8**	262.74	270.02	5.95
Calcium (mg/100 g)	281.03	441.96	6277.79**	462.67	470.96	9.36
Zinc (mg/100 g)	0.12	0.028	0.61**	0.04	0.04	20.36
Iron (mg/100 g)	0.06	1.26	47.47**	2.06	2.38	17.52

*and **=significant at $P \leq 0.05$ and $P \leq 0.01$, respectively. Numbers in parenthesis represent degree of freedom for the respective source of variation. Rep=Replication, CV (%)=Coefficient of Variation in percent, respectively

Estimates of variability components

Phenotypic and genotypic coefficients of variations: The estimated phenotypic (PCV) and genotypic (GCV) coefficient of variations for 9 nutritional quality traits of 36 Ethiopian mustard genotypes are presented in (Table 2). The phenotypic and genotypic coefficients of variation ranged from 1.83 to 56.73% and 1.26 to 53.96%, respectively. The lowest and highest values were calculated for leaf moisture content (%) and iron content for both GCV and PCV. The differences between PCV and GCV were in the range between 0.25 (ash content of leaves) to 3.55% (zinc content) which means all traits could be considered as low (<5%). The low differences between phenotypic and genotypic coefficients of variation is an indication of the less influence of environmental factors in the expression of traits and the higher chance to improve the traits through selection breeding. The close correspondence between the genotypic and phenotypic variations is due to relatively small contribution of the environment to the phenotype expression of the trait. Moisture and dry matter content in percent had also low (<10%) GCV and PCV (Table 2). According to Sivasubramanian and Madhavamenon that PCV and GCV values <10% can be categorized as low. This suggested that selection of genotypes for high mean values of these traits to develop as varieties may not be appropriate breeding method since the genetic potential of the genotypes were less expressed in these traits. The GCV and PCV values in the range between 10 and 20% and >20% can be consider as moderate and high, respectively. Accordingly, high values for both genetic parameters were computed for potassium, calcium, zinc and iron contents. This suggested that most of the traits were less influenced by environmental factors and selection based on phenotypic expression of the genotypes could be applied as breeding method to improve the traits. Singh observed high PCV and GCV value for calcium, iron and zinc content of cabbage genotype and moderate values for both PCV and GCV were calculated for protein, ash and magnesium content. Sarker reported moderate value of PCV and GCV for protein content and magnesium content in vegetable amaranths leaf [8,9].

Table 2: Genetic variability components for 9 traits of 36 Ethiopian mustard genotypes.

Traits	**GCV (%)**	**PCV (%)**	**H2 (%)**	**GA**	**GAM (%)**	**Diff. PCV & GCV**
Moisture content (%)	1.26	1.83	48.03	1.5	1.81	0.56
Dry matter content (%)	6.14	8.85	48.03	1.5	8.76	2.72
Protein content (%)	12.37	14.24	75.53	2.52	22.15	1.86
Ash content (%)	14.27	14.52	96.59	3.73	28.89	0.25
Magnesium (mg/100 g)	13.42	15.53	74.67	12.21	23.89	2.11
Potassium (mg/100 g)	23.82	24.55	94.13	131.47	47.6	0.73
Calcium (mg/100 g)	23.25	25.06	86.04	102.96	44.43	1.81
Zinc (mg/100 g)	52.34	55.89	87.69	1.03	100.96	3.55
Iron (mg/100 g)	53.96	56.73	90.45	9.3	105.71	2.78

Estimates of heritability and genetic advance

Estimates of heritability in broad sense (H^2) and genetic advance as percent of mean (GAM) for 9 nutritional traits of leaf of Ethiopian mustard genotypes presented in Table 2. The heritability values ranged from 48.03 to 96.59. The genetic advance as percent of mean was estimated in the range between 1.81 and 105.71%. As suggested by Johnson, heritability values are categorized as low (<30%), moderate (30-60%) and high (>60%). according to these categories of H2, all traits had high values of heritability except moisture and dry matter content (48.03) had mediumheritability. Buhroy reported high heritability for protein content, iron content in 10 leafy genotypes of amaranths. Tejaswini reported high heritability for protein and iron content in 29 genotypes of vegetable amaranths. The moisture and dry matter contents exhibits low GAM (<10%) whereas GAM (>20%) was high for the remaining traits. Johnson classified genetic advance as percent mean as low (<10%), moderate (10-20%) and high (>20%). In related leafy vegetable crop for mineral content analysis Bozokalfa observed high genetic advance as for calcium, iron, potassium, and zinc in swisschard leaf. The importance of considering both the genetic advance and heritability of traits was suggested than considering these genetic parameters separately to estimate how much progress can be made through selection. In this study, high heritability was coupled with high GAM for all traits except for moisture and dry matter content in which moderate heritability coupled with low GAM for moisture content and moderate heritability coupled with moderate GAM for dry matter content. The results suggested selection of high performing genotypes is possible for the improvement of traits. The high heritability would be a close correspondence between the genotypic and phenotypic variations due to relatively small contribution of the environment to the phenotype expression of the trait [10,11]. Buhroy reported high heritability was associated with high genetic advance for iron content while high heritable with medium genetic advance for protein content. Bozokalfa reported high heritability coupled with high genetic advance as percent of mean for iron, zinc and magnesium whereas high heritability coupled with moderate genetic advance as percent of mean for potassium and calcium content in the leave of Swiss chard.

Conclusion

Ethiopian mustard is a traditional African vegetable, previously gathered from the wild for human consumption and the species is a very common leafy vegetable in Ethiopian cuisine and is much liked. This study was conducted to assess genetic variability, heritability and genetic advance among Ethiopian mustard genotypes leaf for nutritional quality trait. Those 36 Ethiopian mustard genotypes with two replications, a total of 72 sample leaf were evaluated for 9 nutritional quality traits. The research result revealed the presence of highly significant (P<0.01) differences among Ethiopian mustard genotypes for all quantitative traits. The results showed the higher chance of developing Ethiopian mustard genotypes for high nutritional quality traits through selection. All the estimated variability components (GCV, PCV, H2 and GAM) were moderate to high for all traits except moisture and dry matter content. The differences between the values of PCV and GCV were <5%, this showed that most of the traits were highly heritable and transmissible to next filial generation. The research results suggested the higher chance of developing varieties for high nutrition quality through selection and/or crossing of genotypes of Ethiopia mustard.

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