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Genetic variability, correlation and path analysis study for minerals and fruit quality traits in different horticultural groups of muskmelon (*Cucumis melo* L.)

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Abstract

This experiment was carried out to estimate the extent of genetic variability and character association among different fruit quality traits and fruit yield in 67 genotypes of muskmelon from 3 horticultural groups. The experimental results exhibited significant differences among the genotypes for all the fruit quality attributes under study. On the basis of yield and fruit quality attributes, 7 superior genotypes viz., DM-162, DM-159, DM-143, DM-145, DM-31, and DM-56 were identified. Further, high heritability estimates coupled with high genetic gain were observed for all the fruit quality traits under study, which indicated that these traits are under additive gene effects and are more reliable for effective selection. The correlation coefficients (phenotypic and genotypic) among different phytonutrients content along with fruit yield exhibited highly significantly positive association with phosphorus (0.374), potassium (0.451), calcium (0.223), magnesium (0.206) and iron content (0.217). Total soluble solids exhibited significant positive association with vitamin C (0.687), total carotenoids (0.292), zinc (0.252), iron (0.192), manganese (0.146), copper (0.161) and fruit yield per plant (0.156). However, TSS showed significantly negative correlation with acidity (-0.875) and sodium content (-0.177).Path coefficient analysis at genotypic level revealed that total soluble solids showed direct positive effect (0.348) on yield and indirect positive effect via total carotenoids (0.031), potassium (0.009), calcium (0.006), magnesium (0.009) and negative indirect effects via acidity (-0.120), vitamin C (-0.077), zinc (-0.075) and copper content (-0.051) and ultimately exhibited significant positive correlation (0.143).

Keywords: *Cucumis melo* L., Carotenoids, Phytonutrients, TSS, Genetic advance, Heritability, Correlation

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Introduction

Muskmelon (*Cucumis melo* L.) is a highly relished cucurbit because of its attractive fruit with unique aromatic musky flavour, sweet taste and being rich in vitamins and minerals which is extensively being grown worldwide. It is considered as one of the most diverse and highly polymorphic species in Cucurbitaceous family. It was earlier considered to be native of Africa but many new recent researches showed it as of Asian origin and mainly from India. It has been widely cultivated in different regions of the world by humans for ages on account of its delicious and nutritious fruits and edible seeds. Muskmelon also plays an important role in international trade of fruits and vegetables. Information on magnitude of variability and the extent to which desirable characters are heritable is essential to enhance the efficiency of selection for genetic improvement program of musk melon for fruit quality traits. Yield is undoubtedly an important parameter for selection of parents. Yield being a complex quantitative character determined by several component attributing characters. Besides yield, availability of more minerals and nutrients to consumers is highly important. Minerals such as nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, zinc, manganese, boron, chloride and sodium are chemical elements required by human beings to support the various physio-biochemical events involved in sustenance of growth and developments. Billions of people in developing countries suffer from micronutrient malnutrition, also known as "hidden hunger," that is caused by intake of insufficient micronutrients such as Vitamin-A, Zn, and Fe (Singh et al. 2010). For a successful improvement programme, it is extremely important to study the inter-relationships among various characters including yield. It is essential to partition the overall variability into heritable and non heritable components, which will enhance the precision of selection. Again selection of one trait influence a large number of associated traits, which makes it necessary to find out interrelationship of various components both among themselves and with the yield. Improvement in yield and nutritional content is possible only through selection for the desired component characters. Hence, knowledge of association between yield and quality component characters and between component characters is essential for yield and nutritional quality improvement through selection programme. Certain characters might indirectly influence yield, but their correlation with yield may not be statistically significant. In such cases, path coefficient analysis is an efficient technique, which permits the separation of coefficients into components of direct and indirect effects.

Materials and Methods

The experimental materials consisted of 67 genotypes from 3 horticultural groups of melon (*inodorous*, *cantaloupensis* and *momordica*) including six commercial varieties namely Durgapura Madhu, Kashi Madhu, Pusa Madhuras, Hara Madhu, Arka Jeet and Punjab Sunheri. This experiment was conducted in a Randomized Block Design with three replications during the spring–summer season of 2014. The soil texture of the experimental was sandy loam with alkaline reaction and medium fertility. Twenty plants per genotype in each replication were maintained. The mature fruits (Physiological maturity) were analysed for 13 fruit quality traits and yield per plant was calculated and yield/ha was estimated. The fruit samples were dried at 65°C in hot-air oven for 72 h and then ground for making powder which were used for the estimation of nutrient content according to standard procedure. Phosphorus was determined by vanadophosphomolybdate yellow colour method using spectrophotometer. Potassium and sodium were estimated by using flame photometer with facility of internal calibration. Calcium, magnesium content in fruit samples was determined by atomic absorption spectrophotometer. Different micronutrients viz., copper, iron, manganese and zinc content in fruits were estimated from diacid digested fruit samples by using Inductively Coupled Plasma Mass Spectrometry (ICP-MS, Model NexION 300X, Perkin Elmer, USA). The concentration of all phytonutrients was expressed in mg/100 g (dry weight basis). Total soluble solids (TSS, expressed as ^{0}Brix,) were measured from fruit juice using a hand refractometer. Titrable acidity (%) was determined by titration of a fruit juice sample with 0.05 N NaOH, using phenolphthalein as indicator. The broad sense heritability (h^2bs) was estimated for all characters as the ratio of genotypic variance to the total of phenotypic variance. The analysis of variance, heritability in the broad sense and expected genetic gain were carried out according to the standard procedures. The correlation coefficients at phenotypic and genotypic levels were estimated according to methods suggested by Al-Jibouri et al. (1958) and path coefficient analysis was done according to Dewey and Lu (1959).

Results and Discussion

Analysis of variance exhibited significant difference among the 67 genotypes for 13 fruit quality traits and fruit yield. This indicated that the existence of high degree of genetic variability available in the germplasm material could be exploited for future breeding programme. Nevertheless, the analysis of variance by itself is not sufficient and conclusive to elucidate all the inherent genotypic variance in the collections. The improvement in yield and fruit quality depends upon the extent of genetic variability available in breeding materials and the amount to which the major yield and fruit quality contributing traits are heritable from generation to generation. Wide range of variation was observed for most of the traits of economic importance in the present investigation which indicated the presence of sufficient quantity of variation amongst the genotypes for the traits under study. The mean performance of 67 muskmelon genotypes for 13 fruit quality traits and fruit yield showed wide range of variation for many fruit quality traits and about 8-10 times variation was observed for total carotenoids (16.52-192.93), phosphorus (4.45-28.72), potassium (25.80-235.26), magnesium (3.13-29.22), zinc (0.15-1.93), manganese (0.15-1.44), cupper (0.08-0.85) and iron (0.12-1.92) contents and similar range of results for phosphorus, potassium, iron and zinc content in melon from *momordica* and *acidulous* groups were reported by Fergany *et al.* (2011). These results reflected the high selection prospects for these nutritional traits to improve the performance through breeding program. It indicated that sufficient variability existed for all the characters and considerable improvement could be achieved in most of these characters by selection. The values of range reflects the amount of phenotypic variability which is not very reliable since it includes genotypic, environmental and genotype x environmental interaction components and does not revealed to which character is showing higher degree of variability. Further, the phenotype of crop is influenced by additive gene effect (heritable), dominance (non-heritable) and epistatic (non-allelic interaction). Therefore, it becomes necessary to split the observed variability into phenotypic variation (PV) and genotypic variation (GV) which indicates the extent of variability existing for various traits. However, these GV and PV estimates are influenced by the units of measurements of various traits and even these estimates do not always give a correct picture. But, the estimates of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) will indicate the extent of variability existing for various traits irrespective of their units of measurements. In the present investigation, high phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were observed for iron content (56.72, 51.53), zinc content (54.42, 49.57), Copper (55.61, 51.12) total carotenoids (54.77, 51.46) among quality traits (Table 1) and similar results were obtained by Arivalagan et al. (2014) in cucumber for traits for copper, iron and magnesium content. These results reflected wide variability for traits of economic importance and further selection could improve the genotypes. High values of GCV and PCV indicated high genetic variability among the genotypes and better scope for the improvement of the character through selection. On the other hand, large difference between GCV and PCV was observed for acidity (29.27, 37.58) and iron content (56.72, 51.53). This explained the greater role of environmental influence over these characters. Low estimates of PCV and GCV were recorded for the quality parameters like TSS (18.92, 17.99) and vitamin C content of the fruit (16.22, 15.66). These results are in line with the findings of earlier studies by Reddy et al. (2013), Mehta et al. (2009) and Tomar et al. (2008) in muskmelon for fruit length, flesh thickness, yield and TSS. Thus, in the present germplasm, it appears that phenotypic variability for all the quality parameters of muskmelon are true measures of genotypic variability as there is narrow difference between the estimates of GCV and PCV indicating that they are least affected by the environment and comparatively stable. Hence, direct selection based on phenotype would be successful in improvement of these traits/characters. Thus, heterosis based on phenotype would be more effective in improvement of these parameters. However, these coefficients also do not represent comprehensive information about the extent of inheritance of the characters. Heritability of yield and quality characters enables the plant breeder to decide the extent of selection pressure to be applied under a particular environment, which separates out the environmental influence from the total variability. However, its use would be limited as this could be changed with different set of environments as well as breeding materials. The estimation of heritability has a greater role to play in determining the effectiveness of selection for a character provided it is considered in conjunction with the predicted genetic advance. The heritability is influenced by generation of hybrid, sample size of experimental material and environment. High heritability estimates were observed for all quality characters under investigations. The present investigations indicated less influence of environment on these traits. This suggested that selection would be effective and improvement of traits can be followed through using pure line selection method. The high heritability coupled with low to moderate GAM indicated that these traits are governed by non-additive genes. The high heritability is being exhibited due to favorable influence of environment rather than genotypes where little progress would be achieved by applying selection pressure on these traits. The improvement in these traits would be more effective by selecting specific combinations followed by random mating of lines. But, high heritability with high GAM indicated the predominant role of additive genetic component in expression of these traits. Hence, there is scope for improvement of these traits through

Table 1: Estimates of variability, heritability, genetic advance and GA as per cent of mean for fruit yield and fruit quality attributes in muskmelon

S. no	Characters	Range	Grand Mean	PCV (%)	GCV (%)	h^2(%)	Genetic advance	GA as percent mean
1.	TSS (°Brix)	5.50-15.67	10.99	18.92	17.99	90.47	3.87	35.26
2.	Acidity (%)	0.06-0.22	0.12	37.58	29.27	37.58	0.06	46.95
3.	Vitamin C (mg/100g)	11.2-25.0	14.66	16.22	15.66	93.16	4.56	31.14
4.	Total carotenoids (µg/100g)	16.52-192.93	98.71	54.77	51.46	88.29	98.33	99.61
5.	Phosphorus (mg/100g)	4.78-28.72	10.54	42.96	42.14	96.24	8.98	85.16
6.	Potassium (mg/100g)	25.80-235.26	98.22	51.88	49.36	90.54	95.04	96.76
7.	Calcium (mg/100g)	3.13-29.22	12.63	35.59	34.24	92.53	8.57	67.85
8.	Magnesium (mg/100g)	7.82-26.19	14.66	46.23	45.28	95.91	13.39	91.35
9.	Sodium (mg/100g)	2.47-9.81	5.72	30.84	29.44	91.16	3.31	57.91
10.	Zinc (mg/100g)	0.15-1.93	0.69	54.42	49.57	82.98	0.64	93.02
11.	Manganese (mg/100g)	0.15-1.44	0.69	38.8	38.25	97.21	0.54	77.69
12.	Copper (mg/100g)	0.08-0.85	0.25	55.61	51.12	84.48	0.24	96.79
13.	Iron (mg/100g)	0.12-1.92	0.55	56.72	51.53	82.53	0.53	96.44
14.	Yield per plant (kg)	0.56-5.38	2.07	43.45	40.68	87.64	1.62	78.45

phenotypic selection as its estimates of GCV and PCV are closer and parallel and phenotypic variability is a good measure of genotypic variability. High heritability coupled with moderate GAM was recorded for quality parameters like total soluble solids which are in conformity with those obtained by Choudhary et al. (2011) and Ramana (2000) in muskmelon for TSS. This indicated that high heritability is being exhibited due to favourable influence of environment rather than genotypes where little progress would be achieved by applying direct selection pressure on these traits. The improvement in this trait would be more effective by selecting specific combinations followed by random mating of lines. High heritability coupled with high GAM was recorded for quality parameters *viz.,* iron content, total carotenoids, zinc, potassium, calcium, phosphorus, manganese, and magnesium content. High heritability of these characters may be due to additive gene effects and these characters are more likely to respond to direct selection. The phenotypic and genotypic correlation coefficients between different fruit quality traits and yield are presented in Table 2. From the perusal of table in general, the magnitudes of genotypic correlation coefficients were higher than phenotypic correlation coefficients, indicating strong association among various characters studied. Fruit yield per plant exhibited highly significant positive association with phosphorus (0.374), potassium (0.451), calcium (0.223), magnesium (0.206) and iron content (0.217). Total soluble solids exhibited significant positive association with vitamin C (0.687), total carotenoids (0.292), zinc (0.252), iron (0.192), manganese (0.146), copper (0.161) and fruit yield per plant (0.156). Potassium had highly significant and positive association with phosphorus (0.638), magnesium (0.496), yield per plant (0.451), copper (0.445), iron (0.363), calcium (0.319) and zinc (0.250) and similar results were obtained by Arivalagan et al. (2014) for association of potassium with magnesium and zinc content in cucumber. Significant positive correlations were observed between the phosphorus, potassium, iron and zinc concentration in melon by Fergany et al. (2011). Significant negative correlation

Table 2: Association among fruit yield and quality traits of muskmelon

		Total soluble solids (°Brix)	Acidity (%)	Vitamin C (mg/ 100 g)	Total carotenoids (µg/ 100g)	Phosphorus (mg/ 100g)	Potassium (mg/ 100g)	Calcium (mg/ 100g)	Magnesium (mg/ 100g)	Sodium (mg/ 100g)	Zinc (mg/ 100g)	Manganese (mg/ 100g)	Copper (mg/ 100g)	Iron (mg/ 100g)
Total soluble solids (°Brix)	P	1.000												
	G	1.000												
Acidity (%)	P	-0.853**	1.000											
	G	-0.875**	1.000											
Vitamin C (mg/100g)	P	0.653**	-0.428**	1.000										
	G	0.687**	-0.441**	1.000										
Total carotenoids (µg/100g)	P	0.285**	-0.301**	0.059	1.000									
	G	0.292**	-0.307**	0.060	1.000									
Phosphorus (mg/100g)	P	-0.014	0.007	-0.032	-0.085	1.000								
	G	-0.012	0.006	-0.036	-0.089	1.000								
Potassium (mg/100g)	P	0.025	-0.011	0.029	-0.076	0.620**	1.000							
	G	0.026	-0.009	0.029	-0.077	0.638**	1.000							
Calcium (mg/100g)	P	0.034	-0.001	-0.033	-0.078	0.308**	0.308**	1.000						
	G	0.034	-0.006	-0.041	-0.080	0.326**	0.319**	1.000						
Magnesium (mg/100g)	P	-0.071	0.084	-0.105	-0.138	0.555**	0.473**	0.633**	1.000					
	G	-0.077	0.089	-0.118	-0.145*	0.589**	0.496**	0.674**	1.000					
Sodium (mg/100g)	P	-0.166*	0.044	-0.286**	-0.060	0.076	0.090	0.232**	0.297**	1.000				
	G	-0.177*	0.048	-0.323**	-0.066	0.077	0.097	0.254**	0.320**	1.000				
Zinc (mg/100g)	P	0.249**	-0.300**	0.057	0.037	0.357**	0.248**	0.329**	0.285**	-0.051	1.000			
	G	0.252**	-0.305**	0.059	0.039	0.363**	0.250**	0.336**	0.301**	-0.054	1.000			
Manganese (mg/100g)	P	0.142*	-0.252**	0.002	0.068	0.069	-0.024	-0.192**	-0.021	-0.181**	0.200**	1.000		
	G	0.146*	-0.255**	0.004	0.069	0.072	-0.026	-0.200**	-0.021	-0.189**	0.201**	1.000		
Copper (mg/100g)	P	0.156*	-0.182**	-0.017	0.051	0.443**	0.437**	0.481**	0.499**	0.163*	0.637**	0.120	1.000	
	G	0.161*	-0.188**	-0.018	0.052	0.457**	0.445**	0.492**	0.526**	0.167*	0.648**	0.123	1.000	
Iron (mg/100g)	P	0.186**	-0.178*	0.002	0.077	0.376**	0.354**	0.444**	0.408**	0.106	0.694**	0.190**	0.865**	1.000
	G	0.192**	-0.187**	-0.001	0.077	0.386**	0.363**	0.453**	0.427**	0.109	0.702**	0.196**	0.885**	1.000
Fruit Yield (kg/plant)	P	0.143*	-0.074	0.040	0.117	0.339**	0.416**	0.199**	0.189**	0.079	0.001	-0.014	0.147*	0.197**
	G	0.156*	-0.077	0.040	0.130	0.374**	0.451**	0.223**	0.206**	0.095	0.002	-0.011	0.162*	0.217**

was observed with acidity (-0.875) and sodium content (-0.177). Most of the genetic correlations were slightly higher than the corresponding phenotypic correlation. This was expected in part because the heritability estimates were generally high which indicated the lesser role of environmental contributions to the phenotypic variation. Comparatively large difference between the genotypic correlation coefficient and phenotypic correlation coefficient was noted for vitamin C with sodium content (-0.286,-0.323), yield with phosphorous (0.339, 0.374), yield and potassium (0.416, 0.451), TSS with Vitamin C (0.653, 0.687) and magnesium with phosphorous (0.555, 0.589) also. A phenotypic correlation that is lower than the genetic correlation does not imply that a negative environmental correlation is involved. A negative environmental correlation is implied only when the ratio of the phenotypic correlation to the genetic correlation is less than the geometric mean of the stabilities for the two traits. Based on overall results of phenotypic and genotypic correlation, it is possible to breed desirable muskmelon varieties combining high fruit yield, TSS in higher range (more than 12 %) along with higher nutritional content. It is generally believed that large fruit size and high TSS content will not go together. However, in the present investigation a significant positive correlation was observed between fruit yield and TSS both at phenotypic and genotypic levels clearly demonstrated no hindrance in combining high fruit yield and high TSS content in single genotype. It may be mentioned here that although these correlations were positive but the values were lower. Therefore, one has to exert a strong selection pressure simultaneously for these two characters in order to have a balanced combination in a variety. There cannot be two opinions of combining high yield and high TSS content in a single cultivar of muskmelon but the opinion might differ with respect to optimum fruit size which is largely determined by consumer's preference and most of the exotic genotypes from *inodorous* and *cantaloupensis* groups have larger fruit size, high yield and TSS as well. In view of the positive correlation between fruit yield and TSS content, it will be easier to combine high TSS content with larger fruit size.

The estimation of direct and indirect effects of different characters on fruit quality traits is presented in Table 3. Path analysis was carried out at phenotypic and genotypic levels considering fruit yield as dependent character and fruit quality attributes as independent characters. Total soluble solids showed direct positive effect on yield and indirect positive effect via total carotenoids, potassium, calcium, magnesium and negative indirect effects via acidity, Vitamin C, zinc and copper content and ultimately exhibited significant positive correlation. Total soluble solids showed higher value for direct effect on yield per plant and lower indirect effect via iron, total carotenoids; negative indirect effects via acidity, vitamin C and zinc content which in turn showed significant positive correlation. Such correlation analysis will facilitate selection of genotype with improved nutritional quality, as selection for one trait leads to selection of correlated other traits (Wricke and Weber 1986). Path analysis was explained for those characters only which showed significant correlations with yield like Total soluble solids which showed direct positive effect on yield and indirect positive effect via total carotenoids, potassium, calcium, magnesium and negative indirect effects via acidity, Vitamin C, zinc and copper content and ultimately exhibited significant positive correlation. Selection of genotypes with higher TSS (ÚBrix), vitamin C, total carotenoids, potassium, calcium, magnesium, sodium, zinc and iron content are desirable for improved fruit quality in muskmelon. Correlation and path analysis revealed that the traits like TSS (ÚBrix), vitamin C, potassium, calcium, magnesium, sodium, zinc and iron are regarded as primary quality contributing components which can be effectively utilized through selection in muskmelon varietal improvement programme for nutritional quality.

सारांश

खरबूजा के 67 प्रभेदों में फल गुणावत्ता व उपज का अनुवांशिक विविधता एवं गुण सम्बन्ध ज्ञात करने के तीन औद्यानिक समूहों का अध्ययन किया गया। प्रायोगिक परिणाम के अध्ययन से गुणवत्ता घटकों के प्रति प्रभेदों में सार्थक विविधता पायी गयी। उपज एवं फल गुणवत्ता घटकों के आधार पर 7 उत्कृष्ट प्रभेदों जैसे– डी.एम.–162, डी.एम. –159, डी.एम.–143, डी.एम.–145, डी.एम.–31 व डी.एम.–56 की पहचान की गयी। अध्ययन के अन्तर्गत उच्च वंशागतित्व के साथ उच्च अनुवांशिक लाभ सभी फल घटकों में पाया गया। जिससे स्पष्ट होता है कि ये सभी गुण योज्य जीन प्रभाव से प्रभावित होते हैं और ये प्रभावी चयन के लिये विश्वसनीय हैं। सहसम्बन्ध गुणांक (लक्षण प्ररूप व अनुवांशिक प्ररूप) विविध पोषक तत्वों की मात्रा के साथ फल उपज ने उच्च सार्थक धनात्मक सह सम्बन्ध फास्फोरस (0.374), पोटैशियम (0.451), कैल्शियम (0.223), मैग्नीशियम (0.206) व लौह तत्व (0.217) स्पष्ट किया। कुल विलेय ठोस का सार्थक धनात्मक सम्बन्ध विटामिन सी (0.687), कुल कैरोटीनोयड्स (0.292), जिंक (0.252), लौह (0.192), मैग्नीज (0.146), कॉपर (0.161) व उपज/पौधा (0.156) से पाया गया। जबकि कुल विलेय ठोस का सार्थक ऋणात्मक सहसम्बन्ध अम्लता (–0.875) व सोडियम की मात्रा (–0.177) से पाया गया। अनुवांशिक स्तर पर पथ गुणांक विश्लेषण से स्पष्ट हुआ कि कुल विलेय ठोस ने प्रत्यक्ष धनात्मक प्रभाव (0.348) उपज व अप्रत्यक्ष धनात्मक प्रभाव कुल कैरोटीनायड्स (0.031), पोटैशियम (0.009), कैल्शियम (0.006), मैग्नीशियम (0.009) व नकारात्मक प्रभाव द्वारा अम्लता (–0.120), विटामिन सी (–0.077), जिंक (–0.077), जिंक (–0.075) व ताँबा (–0.051) का सार्थक धनात्मक सहसम्बन्ध (0.148) पाया गया।

Table 3: Direct and indirect effects of component quality characters on fruit yield of muskmelon

		Total soluble solids (°Brix)	Acidity (%)	Vitamin C (mg/ 100g)	Total carotenoids (µg/ 100g)	Phosphorus (mg/ 100g)	Potassium (mg/ 100g)	Calcium (mg/ 100g)	Magnesium (mg/ 100g)	Sodium (mg/ 100g)	Zinc (mg/ 100g)	Manganese (mg/ 100g)	Copper (mg/ 100g)	Iron (mg/ 100g)	Yield per plant (kg)
Total soluble solids (°Brix)	P	**0.348**	-0.120	-0.078	0.031	-0.004	0.009	0.006	0.009	-0.009	-0.075	0.003	-0.051	0.074	0.143*
	G	**0.547**	-0.259	-0.130	0.034	-0.004	0.010	0.007	0.016	-0.015	-0.080	0.006	-0.063	0.086	0.156*
Acidity (%)	P	-0.297	**0.141**	0.051	-0.033	0.002	-0.004	-0.001	-0.011	0.002	0.090	-0.005	0.059	-0.071	-0.074
	G	-0.479	**0.296**	0.084	-0.036	0.002	-0.003	-0.001	-0.019	0.004	0.097	-0.011	0.074	-0.084	-0.077
Vitamin C (mg/100g)	P	0.228	-0.060	**-0.119**	0.006	-0.008	0.010	-0.005	0.014	-0.015	-0.017	0.001	0.006	0.001	0.04
	G	0.376	-0.130	**-0.190**	0.007	-0.011	0.011	-0.009	0.025	-0.027	-0.019	0.001	0.007	-0.001	0.04
Total carotenoids (µg/100g)	P	0.099	-0.043	-0.007	**0.109**	-0.022	-0.027	-0.013	0.018	-0.003	-0.011	0.001	-0.017	0.030	0.117
	G	0.160	-0.091	-0.011	**0.116**	-0.027	-0.030	-0.017	0.031	-0.006	-0.012	0.003	-0.021	0.035	0.13
Phosphorus (mg/100g)	P	-0.005	0.001	0.004	-0.009	**0.253**	0.216	0.050	-0.073	0.004	-0.108	0.001	-0.145	0.149	0.339**
	G	-0.007	0.002	0.007	-0.010	**0.308**	0.242	0.070	-0.126	0.007	-0.116	0.003	-0.179	0.173	0.374**
Potassium (mg/100g)	P	0.009	-0.002	-0.004	-0.008	0.157	**0.349**	0.050	-0.062	0.005	-0.075	-0.001	-0.143	0.140	0.416**
	G	0.014	-0.003	-0.006	-0.009	0.196	**0.380**	0.068	-0.106	0.008	-0.080	-0.001	-0.175	0.163	0.451**
Calcium (mg/100g)	P	0.012	-0.001	0.004	-0.009	0.078	0.108	**0.161**	-0.083	0.012	-0.099	-0.003	-0.157	0.176	0.199**
	G	0.019	-0.002	0.008	-0.009	0.100	0.121	**0.213**	-0.144	0.022	-0.107	-0.009	-0.193	0.204	0.223**
Magnesium (mg/100g)	P	-0.025	0.012	0.013	-0.015	0.141	0.165	0.102	**-0.131**	0.016	-0.086	-0.001	-0.163	0.162	0.189**
	G	-0.042	0.027	0.022	-0.017	0.181	0.189	0.144	**-0.213**	0.027	-0.096	-0.002	-0.207	0.192	0.206**
Sodium (mg/100g)	P	-0.058	0.006	0.034	-0.007	0.019	0.032	0.037	-0.039	**0.053**	0.015	-0.003	-0.053	0.042	0.079
	G	-0.097	0.014	0.061	-0.008	0.024	0.037	0.054	-0.068	**0.085**	0.017	-0.008	-0.066	0.049	0.095
Zinc (mg/100g)	P	0.087	-0.042	-0.007	0.004	0.090	0.086	0.053	-0.037	-0.003	**-0.302**	0.004	-0.208	0.275	0.001
	G	0.138	-0.090	-0.011	0.005	0.112	0.095	0.072	-0.064	-0.005	**-0.318**	0.009	-0.255	0.315	0.002
Manganese (mg/100g)	P	0.049	-0.036	-0.001	0.007	0.018	-0.009	-0.031	0.003	-0.010	-0.060	**0.018**	-0.039	0.075	-0.014
	G	0.080	-0.076	-0.002	0.008	0.022	-0.010	-0.043	0.005	-0.016	-0.064	**0.043**	-0.048	0.088	-0.011
Copper (mg/100g)	P	0.054	-0.026	0.002	0.006	0.112	0.152	0.077	-0.065	0.009	-0.192	0.002	**-0.326**	0.342	0.147*
	G	0.088	-0.056	0.003	0.006	0.140	0.169	0.105	-0.112	0.014	-0.206	0.005	**-0.393**	0.398	0.162*
Iron (mg/100g)	P	0.065	-0.025	-0.001	0.008	0.095	0.123	0.071	-0.053	0.006	-0.209	0.003	-0.282	**0.396**	0.197**
	G	0.105	-0.055	0.001	0.009	0.119	0.138	0.097	-0.091	0.009	-0.223	0.009	-0.347	**0.449**	0.217**

Phenotypic Residual effect = 0.68078; Genotypic Residual effect=0.59894; Diagonal (under lined) values indicate direct effects G: Genotypic P: Phenotypic

References

Al Jibouri HA, Miller PA and Robinson HF (1958) Genotypic and environmental variances and covariances in an upland cotton cross of interspecific origin. Agron J 50: 633-636.

Arivalagan M, Bhardwaj R, Ranjan P, Prasad TV and Gangopadhyay KK (2014) Variability in minerals composition of cucumber genotypes collected from Northern India. Indian J Hort 71(4): 505-510.

Choudhary H, Ram HH and Singh DK (2011) Genetic variability study in Muskmelon. Prog Hort 43 (2):231-233.

Dewey DR, Lu KN (1959) Correlation and path coefficient analysis of components of crested, wheat grass seed production. Agron J 51: 515-518.

Fergany M, Kaur B, Monforte AJ, Pitrat M, Rys C, Lecoq H, Dhillon NP and Dhaliwal SS (2011) Variation in melon (*Cucumis melo* L.) landraces adapted to the humid tropics of southern India. Genetic Res Crop Evo 58(2):225-43.

Mehta R, Singh D and Bhalala MK (2009) Correlation and path analysis in Muskmelon. Indian J Hort 66 (3): 396-399.

Ramana, NV (2000) Studies on genetic divergence in oriental pickling melon. PG Thesis, Acharya N G Ranga Agricultural University Hyderabad.

Reddy BPK, Begum H, Sunil N, Reddy MT, Babu JD and Reddy RSK (2013) Correlation and path coefficient analysis in muskmelon (*Cucumis melo* L.). Suranaree J Sci Technol 20(2):135-149.

Singh BK, Sharma SR and Singh B (2010) Variation in mineral concentrations among cultivars and germplasms of cabbage. J Plant Nutrition 33(1): 95-104.

Tomar RS, Kulakarni GU, Kakade OK, Patel AD and Archarya RR (2008) Genetic divergence in muskmelon (*Cucumis melo* L.). Asian J Hort 3: 103-105.

Wricke G and Weber W (1986) Quantitative Genetics and Selection in Plant Breeding. W. de Gruyter, Berlin, Germany, pp 411.