The Bioscan 11(4):3081-3085,2016(Supplement on Genetics and Plant Breeding) www.thebioscan.com
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES

GENETIC VARIABILITY STUDIES IN FRUIT QUALITY PARAMETERS OF KASHMIRI NAKH (*PYRUS PYRIFOLIA* NAKAI.)

AARIFA JAN*, W. M. WANI, K. M. BHAT, M. A. MIR, REHANA JAVID, DANISH BASHIR, JAHANGEER A. BABA AND J. A. RATHER
Division of Fruit Science, Sher-E-Kashmir,
University of Agricultural Sciences and Technology of Kashmir, Srinagar - 190 025 (J & K)
e-mail: aarifa711@gmail.com

KEYWORDS
Clusters
Genetic variability
Kashmiri Nakh
Quality
Pear

Received on :
19.10.2016

Accepted on :
13.12.2016

***Corresponding author**

ABSTRACT
Three districts of Kashmir valley were explored for assessment of variability of fruit quality among Kashmiri Nakh Accessions. Among thirty accessions of Kashmiri Nakh two (KN-12 and KN-13) were having fine texture of flesh, one accession (KN-28) was having maximum area of over colour. The highest TSS of 17°B was recorded in KN-12 while the highest total sugars were recorded in KN- 28 (11.5%). The acidity of fruits varied from 0.11 to 0.46%, the lowest acidity (0.11%) was recorded in KN 24. The cluster dendrogram performed on the basis of studied parameters to assess pattern of diversity, differentiated accessions into six clusters and exhibited significant variability among the accessions. Each cluster has its uniqueness that separated it from other clusters. Cluster VI was characterized by maximum fruit firmness (8.29 kg/cm^2), cluster I is characterized by highest TSS (15.31°B), cluster III had lowest acidity percentage (0.11%). The cluster IV has highest juice content (78.58%) while cluster V is characterized by having highest percentage of total sugars (11.15%) and reducing sugars (7.15%). These results suggest that variability accounted for fruit quality was due to either genotypes or environmental conditions prevailing in the growing areas or interaction of both the factors.

INTRODUCTION

The genus *Pyrus* belongs to the subfamily Pomoideae and family Rosaceae with a basic chromosome number of x = 17 and about 20 primary species proposed by Challice and Westwood (1973) are generally accepted by the most taxonomists. Pear stands 2nd after apples as the most frequently consumed fruit and the most economically important tree fruit in temperate zones of the world (Ahmed *et al.*, 2011). In India, pear cultivars commercially grown belong to *Pyrus pyrifolia* and *Pyrus communis* group. The Chinese sand pears are widely grown in North Western Himalayan region including Jammu and Kashmir, Himachal Pradesh and Uttrakhand. The maximum area under cultivation of Chinese sand pear is existed in Kashmir valley. Therefore, it is locally known as "Kashmiri Nakh". It is also believed that Kashmiri Nakh is one of the naturalized indigenous cultivars grown since ancient time in India (Verma *et al.*, 2014). The morphological characteristics of fruit in *Pyrus* genotypes are variable with respect to genetics and environments.

To meet the need for more food and provide reservoir of genetic variation to the breeders for finding particular characters such as resistance genes for diseases, pests and for adaptation to wider ecological conditions, it will be necessary to make better use of a broader range of the world's plant genetic diversity. Genetic variability studies provide basic information regarding the genetic properties of the population based on which breeding methods are formulated for further improvement of the crop (Yadav *et al.*, 2104). However, (Khan *et al.*, 2015) reported that genetic variability is a basic information needed for the breeders to improve the crops by adopting appropriate method of selection based on variability that exist in the material. Evidences exist that the germplasm resources of fruit plants are threatened to extinction (Bennett, 1965; Frankel, 1975). Such reductions have serious implication for food security in the long term. Therefore, conservation and sustainable use of genetic resources is important to meet the demand for future food security. The wide diversity of the pear genotypes has great variability in their fruit quality. Therefore, characterization for all existing variation within genotypes is of vital importance. The paper deals with the genetic variability studies in fruit quality parameters of *Pyrus pyrifolia* Nakai.

MATERIALS AND METHODS

The present investigation was carried out in three districts of Kashmir Valley *viz.*, Anantnag, Budgam and Kulgam. The survey was conducted for two years 2013 and 2014 and observations were recorded as per the International Union for the Protection of New Varieties of plant standard descriptor (UPOV, 2000). The data presented is pooled date of two years 2013 and 2014. Accessions were selected at fruit maturity stage from different locations of the three districts and earmarked with durable label (aluminum sheet) during initial survey. Thirty accessions were selected for distinct characteristics of horticultural interest for characterization. The fruits were evaluated for different quality parameters. Fruit

texture was evaluated by a panel of ten members against a scale (Ahmed *et al.,* 2011). The ten fruits of each accession were presented to the panel. The over colour of fruits was measured by colour chart. The fruit firmness was recorded by Panetrometer and presented as kg/cm^2. Ten fruits from each accession were cut into halves and seeds were removed from the flesh. Total soluble solids were recorded by using hand refractrometer at room temperature and readings are presented in °Brix. The juice of each genotype was extracted by a blender and preserved in glass beaker separately. The juice was then analyzed for juice content %, acidity (%) using titration method as per the (A.O.A.C., 2000), total sugars (%), reducing (%) and non reducing sugars (%) were also estimated using Fehling's A. B solution as indicators. Sugars were estimated using the method described by Hortwitz (1960) and expressed as percentage of juice.

RESULTS AND DISCUSSION

The fruit quality is determined by internal composition such as contents of sugars, acids and other characteristics like texture, firmness and flavor. Fruit texture and flavor including sugars, acids and aroma are important traits of fruit quality (Jaeger *et al*., 1998). The data is presented in Table 1. In present study it has been observed that only 2 (6.66%) accessions had fine texture of flesh, while 18 (60%) had medium and rest 10 (33.33%) had coarse texture of flesh. Chen *et al*. (2007) found that different pear cultivars have different chemical compositions and heritability of texture of traits are often low to moderate influenced by prevailing environmental conditions. Data pertaining to the relative area of over colour in present study showed that 11 (36.66%) accessions did not show any over colour, while 14 (46.66%) accessions showed small amount of relative area of over colour, while 4 (13.33%) accessions showed medium area of over colour and 1 (3.33%) accession showed a large area of over colour. Fruit colour is an important parameter to evaluate fruit characters which directly correlate with environmental conditions in prevailing localities. Fruit colour is significantly influenced by temperature, location of plant, light penetration and growth habit of tree. Sunlight is main factor responsible for synthesis of anthocyanin synthesis in fruit skin (Erez and Flore, 1986) and thus fruit colour (Marini *et al*., 1991).

The firmness of the accessions ranged between soft, medium and firm. The fruit firmness ranged from 5.3-9.79 kg/cm^2, the highest fruit firmness of 9.79 kg/cm^2 was recorded in KN-5 and lowest fruit firmness was recorded in 5.3 kg/cm^2 in KN- 27. These variations may be due to differences in cell density per unit area in different genotypes. Bhat (2012) reported that fruit firmness varied significantly among pear genotypes with mean values ranging from 4.46 to 14.30 kg/cm^2 during 2010. Similar variations in fruit firmness were also observed by Sandhu *et al*. (2002) and Shyamali (2006). Similarly, juiciness of flesh also showed a wide variability among the thirty Kashmiri Nakh accessions under study. The juice content ranged from 32.88 to 83.65% among thirty Kashmiri Nakh accessions. The highest juice (%) was recorded in KN-4 (83.65%) followed by 83.05% in KN-5. The lowest juice content (32.88%) was recorded in KN-9. Vaysse *et al*. (2005) reported that both the Ellioy and Conference scored high on the criteria of texture, juciness and melting texture. Despite a high crunchiness score, Winter Forelle also scores well on juiciness criterion.

Chemical aspects of fruits such as total soluble solid, acidity and sugars provide important information to the consumers in terms of recognizing a more nutritious fruit (Drogoudi *et al.,* 2008). Data procured from two years study showed a great variability on TSS. The maximum TSS (17 °B) was recorded in KN-12 whereas, minimum TSS (9.20 °B) was recorded in KN-5. TSS is influenced by environmental factors such as temperature, light (duration and intensity), rainfall/supply of water and locations (Ahmed, 2008). Trees with high moisture availability showed less TSS compared to scare water supply with higher contents of soluble solids in pear fruits (Wang, 1982). This indicates that the variability in fruit characteristics especially in fruit composition was not only genetic factor but also influenced by climatic factors. Total soluble solids ranged from 12.9 to 17.8°B and maximum TSS expressed by genotype THB-1 followed by CB-7 and CB-2, least in THP-3 (Verma *et al.,* 2014). With respect to acidity there were evident differences the highest acidity (0.46%) was recorded in KN 15, while lowest acidity (0.11%) was recorded in KN 24. The variation in fruit acidity may be due to different rates of conversion of organic acids into soluble sugars by different genotypes. Similar results were obtained by Raina *et al*. (2011) who reported that average data of acidity showed a significant variation in acid content among different groups of pear varieties. The highest acid content (0.50%) was recorded in strain I and lowest in (0.26%) Strain IV and V among hard pears whereas among soft pears they reported that maximum acidity was observed in Packham's Triumph (0.40%) and lowest in Nijisseki (0.19%).

Sugar is an important component of fruits which correlates with sweetness and is basic ingredient of fruit quality (aroma, texture and flavour). Pear fruits are rich source of carbohydrates as there contain good quality of sugars and dietary fibre (Blattny, 2003). The data obtained in the present study revealed a high variability among the accessions regarding total sugars, reducing and non-reducing sugars. The mean values of both

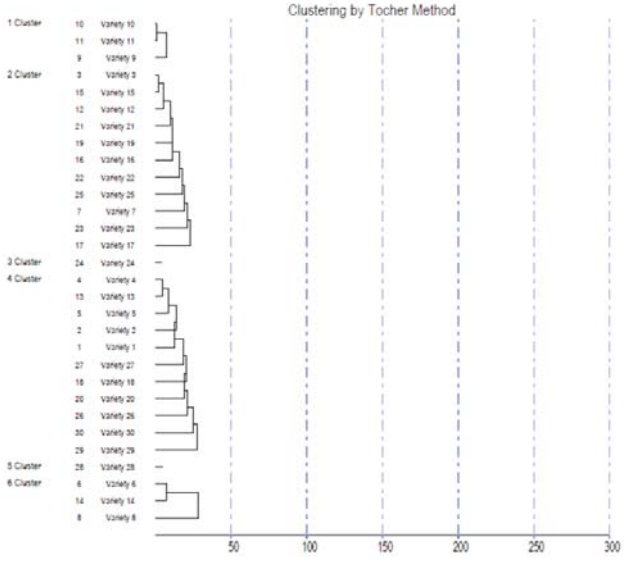

Figure 1: Dendrogram based on quality parameters of thirty pears (*Pyrus pyrifolia* Nakai.) accessions

Table 1: Mean values for fruit quality parameters of Kashmiri Nakh accessions

Accession Name	Texture of flesh	Over colour	Juice content (%)	Fruit firmness (kg/cm^2)	TSS (^{0}B)	Acidity (%)	Total sugars (%)	Reducing sugars (%)	Non Reducing (%)
KN- 1	Coarse	Absent	81.91	6.65	11.7	0.13	10.60	5.700	4.90
KN-2	Medium	Small	79.15	6.29	13.55	0.23	9.10	5.70	3.40
KN-3	Medium	Small	67.90	6.58	13.30	0.15	7.05	5.55	1.50
KN-4	Medium	Small	83.65	9.53	14.70	0.25	5.95	5.50	0.41
KN-5	Medium	Small	83.05	9.79	9.20	0.18	6.10	5.10	1.00
KN-6	Medium	Medium	52.65	9.78	15.30	0.24	5.15	4.85	0.30
KN-7	Medium	Small	59.23	7.98	13.80	0.16	6.25	4.65	1.60
KN-8	Medium	Small	43.14	7.09	9.80	0.15	5.30	4.95	0.35
KN-9	Coarse	Small	32.88	6.91	15.01	0.29	6.35	4.40	1.95
KN-10	Medium	Small	38.15	7.06	15.65	0.18	5.40	4.90	0.50
KN-11	Medium	Absent	37.35	5.74	15.25	0.24	5.70	5.40	0.31
KN-12	Fine	Medium	69.00	6.42	17.00	0.22	5.20	4.50	0.70
KN-13	Fine	Medium	84.05	6.46	13.90	0.23	6.95	5.95	1.00
KN-14	Coarse	Small	52.63	8.05	11.70	0.16	6.25	4.80	1.45
KN-15	Medium	Absent	67.90	7.48	12.65	0.27	5.40	4.50	0.86
KN-16	Medium	Absent	62.75	6.55	13.35	0.28	5.15	4.65	0.50
KN-17	Coarse	Medium	58.55	6.38	10.75	0.33	7.40	6.60	0.80
KN-18	Medium	Absent	76.00	8.72	15.00	0.46	7.30	4.60	2.70
KN-19	Coarse	Absent	63.85	9.68	14.75	0.37	4.50	3.95	0.55
KN-20	Coarse	Small	76.00	5.43	14.70	0.19	8.95	7.40	1.55
KN-21	Coarse	Small	66.25	9.60	13.85	0.28	9.40	6.40	2.83
KN-22	Coarse	Small	65.20	8.62	11.80	0.19	10.47	7.30	3.16
KN-23	Medium	Small	59.55	6.85	11.35	0.33	9.00	5.55	3.45
KN-24	Medium	Absent	59.90	6.22	11.51	0.11	11.00	5.25	5.75
KN-25	Medium	Absent	60.55	9.03	14.15	0.23	8.60	6.10	2.50
KN-26	Coarse	Absent	74.80	9.73	12.35	0.17	9.40	5.45	3.95
KN-27	Medium	Small	77.85	5.30	9.80	0.19	10.20	6.70	3.33
KN-28	Medium	Large	57.78	8.19	10.85	0.22	11.15	7.15	4.00
KN-29	Medium	Small	74.80	7.36	10.84	0.26	10.60	3.25	7.35
KN-30	Coarse	Absent	73.15	6.22	10.51	0.16	9.44	6.25	3.15
Mean	-	-	64.65	7.52	12.93	0.23	7.64	5.43	2.19
Range	-	-	32.88-84.05	5.3-9.79	9.2-17.0	0.11-0.46	4.5-11.15	3.25-7.40	0.30-7.35
CV	-	-	0.28	0.69	1.17	4.35	1.43	1.84	7.21

Table 2: Distribution of different accessions into clusters based on D^2 statistics

Cluster	Number of genotypes in the cluster	Accession No. of the genotypes
I	3	KN- 10, KN-11, KN-9
II	11	KN- 17, KN- 23, KN- 7, KN- 25, KN- 22, KN- 16, KN- 19, KN- 21, KN- 12, KN- 15, KN- 3
III	1	KN- 24
IV	11	KN- 4, KN- 13, KN- 5, KN- 2, KN- 1, KN- 27, KN- 18, KN- 20, KN- 26, KN- 30, KN- 29
V	1	KN- 28
VI	3	KN-6, KN-14, KN-8

Table 3: Average inter-cluster (below diagonal) and intra- cluster (diagonal) distance values among pear (*Pyrus pyrifolia* Nakai.)

	Cluster 1	Cluster II	Cluster III	Cluster IX	Cluster V	Cluster VI
Cluster I	19.95					
Cluster II	798.30	51.59				
Cluster III	636.61	75.19	0.00			
Cluster IV	1859.45	278.45	393.53	63.10		
Cluster V	541.15	89.38	15.48	474.19	0.00	
Cluster VI	224.03	257.85	195.58	918.38	145.27	80.76

Table 4: Cluster means for various quality traits in different clusters of pear (*Pyrus pyrifolia* Nakai.)

	Juice content (%)	Fruit firmness (kg/cm^2)	TSS (^0B)	Acidity (%)	Total sugars (%)	Reducing sugars (%)	Non Reducing (%)
Cluster I	36.13	6.57	15.31	0.24	5.82	4.90	0.92
Cluster II	63.70	7.74	13.34	0.26	7.13	5.43	1.68
Cluster III	59.90	6.23	11.51	0.11	11.00	5.25	5.75
Cluster IV	78.58	7.41	12.39	0.22	8.60	5.60	2.98
Cluster V	57.79	8.19	10.85	0.22	11.15	7.15	4.00
Cluster VI	49.48	8.29	12.28	0.19	5.57	4.87	0.70

years are presented in table which revealed that highest mean values for total sugars (11.15%) was recorded in the fruits of KN- 28 and the lowest amount of total sugars 4.50% was recorded in the fruits of KN-19. Regarding reducing sugars that highest mean values for reducing sugars (7.40%) was recorded in the fruits of KN-20 and the lowest amount of reducing sugars 3.19% was recorded in the fruits of KN-19 whereas, that highest mean values for non-reducing sugars (7.35%) was recorded in the fruits of KN-29 and the lowest amount of non-reducing sugars 0.30% was recorded in the fruits of KN-6. Such variability might be due to variability in rainfall or maturity level at the time of harvesting. Similar results were obtained by Ahmed *et al*. (2011) who found significant differences among the accessions regarding total sugars which ranged from 4.77 to 12.34%. Four accessions locally called as Frashishi remained at the top in terms of sugar percentage as compared to other accessions. Hudina and Stamper (2005) reported that excessive water supply decreased the sugar contents in pear fruits and vice versa.

To assess the variability for these quality parameters, a dendrogram was constructed on the basis of mean values of two years data. Mean, range values and coefficient of variance for each parameter is given in Table 1. All the 30 accessions were grouped into six clusters (Fig. 1). The names of the accessions in each cluster are given in the Table 2. Three (KN-10, KN-11, KN-9) accessions fell in cluster I, eleven (KN- 17, KN- 23, KN- 7, KN- 25, KN- 22, KN- 16, KN- 19, KN- 21, KN-12, KN- 15, KN- 3) in cluster II, one (KN- 24) in cluster III, eleven (KN- 4, KN- 13, KN- 5, KN- 2, KN- 1, KN- 27, KN- 18, KN-20, KN- 26, KN- 30, KN- 29) in cluster IV, one (KN- 28) in cluster V and three (KN-6, KN-14, KN-8) in cluster VI. The formation of different clusters with variable number of accessions indicates variability among accessions. Dendrogram illustrated variability at different levels between the accessions of different clusters and relatedness among the accessions within the same cluster. Genetic variability in *Pyrus* species is probably due to heterogeneity, diversity in environments and hybrid progeny (Katayama & Uematsu, 2006).

The intra- cluster distances ranged from 0.00 to 80.76 (Table 3) indicating that the accessions have dissimilarity for quality traits. The maximum divergence was observed between the accessions of cluster I and cluster IV (inter- cluster distance 1859.45) followed by cluster IV and VI (918.38). The least divergence was recorded between cluster VI and cluster V (15.48). The inter-cluster distances were larger than the intra-cluster distances showing a wide variability among the accessions of clusters with respect to the character considered. Maximum inter-cluster distances indicate that accessions falling in these clusters had wide variability and can be used as better parents for hybridization. Based on the performance of different accessions and cluster analysis the accessions with different quality traits could serve as outstanding source of germplasm for breeding programmes. The cluster means for various quality traits is presented in Table 4. The data in the table indicated considerable differences for all the quality parameters among accessions. Each cluster has its uniqueness that separated it from other clusters. Cluster VI is characterized

by maximum fruit firmness (8.29 kg/cm^2), cluster I is characterized by highest TSS (15.31 ^{0}B), cluster II is characterized by highest percentage of acidity (0.26%), cluster III is characterized by lowest acidity percentage (0.11%) and highest non reducing sugars (5.75%). The cluster IV has highest juice content (78.58%) while cluster V is characterized by having highest percentage of total sugars (11.15%) and reducing sugars (7.15%). The cluster analysis showed a high degree of variability between accessions and if chosen for hybridization programme may give high heterotic F1s and broad spectrum segregating generations (Martinic *et al.,* 2007).

ACKNOWLEDGEMENT

INSPPIRE- DST India is highly acknowledged for providing funding support.

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