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Genetic Diversity Assessment of Japanese persimmon Using Morphological Markers and Its Contribution towards Livelihood in District Gilgit

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Abstract

Japanese persimmon (*Diospyros kaki L.*) is a delicious fruit tree. It is grown relatively warm areas (<1500 m asl) of Gilgit Baltistan. Around four million tons are produced globally. China, being major producer contributes almost 80% followed by Korea and Japan (0.4 and 0.2 million tons) respectively. Asian countries collectively produce 95% of the total worldwide production. There is no record of persimmon production is available from Pakistan. However, Gilgit-Baltistan has the highest production followed by Swat. Study conducted in district Gilgit revealed that it has least contribution into local economy. Fruit is harvested in October to December. Mature plant produces an average of 151.8kg (Std. Dev.103.58749) annually. Sixty-four percent is sold for a mean price of 13.2 (Std. Dev.6.62) Pak rupees per kilogram. Mean household consumption was 25.65kg (Std. Dev.25.52). Mean DBH of 78.59cm (Std. Dev. 54.5136) and 20 ft high. Average life span estimate was 59.3-year (Std. Dev. 27.57198). Contrary to several medicinal uses in the world, people (>98%) in the area never use it as medicine except some rare use for skin fairness and improving blood circulation (<2%). About 80% trees flower as early as in April, fruiting starts in May (82%) and 84% harvested in November.

Majority population (78%) is disease free. Around 78% farmers believe that it requires low water and fertilization. Mean leaf size was 257.52cm^2 (length 11.57cm, width 22.2cm). Ten leaves have a mean weight of 0.82g. Mean fruit height recorded was 4.2cm, diameter 6.0cm and weight 121.4g. Three varieties exist in the area. Dendrogram constructed using Hierarchical clustering showed that use of leave and fruit quantitative morphological characters cannot be used towards any discrimination and taxonomic classification. There is no selective breeding nor any value chain development programmes to improve depreciating gene pool in changing climatic conditions. Besides, its promotional efforts, detailed investigations are required to document biochemical, molecular and morphological markers.

Keywords: Hierarchical clustering; Ebenaceae; Morphological markers; Dendrogram; Gilgit-baltistan

Introduction

Persimmon belongs to the genus Diospyros of the family Ebenaceae [1]. It bears the ebony wood, an important timber for furniture [2]. Nearly 400 species are present in this genus; mostly these species are natives of tropical and subtropical regions. Japanese persimmon (*Diospyros kaki*, Thunb.) a fruit tree originated from East Asia, is nowadays grown in several countries, Italy included [3].

The astringent persimmon fruits contain large quantities of tannin, which is polymer of catechin group such as epigallocatechin gal late, epigallocatechin, epicatechin gal late and epicatechin [4]. There are many methods for increase shelf life, such as drying and making fruit juice fresh fruits have a short shelf life [5]. Four species of Diospyros, namely, Diospyros kaki, Diospyros Virginian, Diospyros oleifera and Diospyros lotus among them Diospyros kaki (Japanese persimmon) is the most important species from commercial point of view [6]. Mealy bugs are known to attack persimmon in Japan, France, Iran, Italy, Israel, and New Zealand California etc. [7]. The honeydew causes the black knot after sucking the fruits. The main transferring factors of the mealy bugs are ants [8].

The fruit of persimmon is used medicinally very important for the treatment of burns, dropsy, diarrhea, gonorrhea, candidacies, dysentery, fevers, thrush, fungal and bacterial infections, gastrula bleeding, sore throats [9]. Persimmon fruit can be considered as a highly nutritional product because of important antioxidant capacity induced by a high content [10].

Japanese persimmon is commonly grown in Gilgit city and around the warm areas of Gilgit-Baltistan Persimmon is a tree having with edible fruits. It is commonly known in local language "Hermit [11]. Ripening of fleshy fruit is the last stage of fruit ontogeny developmental phase and involves many physiological, biochemical and genetic changes [12]. Ethylene

affects many aspects of plant growth and development as a plant hormone and has been played a major role in the ripening of climacteric fruits [13].

Based on effect of pollination persimmon cultivars are classified into four groups on flesh colour and their patterns of astringency loss [14]. The leaves of persimmon played an important role in Chinese system of medicines. The compositions of persimmon leaves were flavonoids, terpenoids, etc. [15]. It was shown that high dietary fiber diets are associated with prevention and treatment of coronary heart diseases (CAD) [16]. The total production of persimmon throughout the world is 4 Million tones and China the production is more than 80% of the total world yield [17].

Study was aimed at investigating genetic distances among the persimmon varieties grown in the district Gilgit of Gilgit-Baltistan province, Pakistan. Persimmon has never been explored for its contribution at household level in the area. This study will help concerned agriculture department, farmers and researchers to build on the results to transform persimmon into more contributing into farmers household economy.

Materials and Methods

Study area

Current study was conducted in five villages of district Gilgit (Figure 1). These villages produce Persimmon. Several families in these villages use it as income generation source. These villages are Dan yore, Sultan Abad, Muhammad Abad, Diding Das, and Jutel. Climate in the area is dominantly cool and chilling winter spreads over November to March followed by extreme hot weather. Mostly people grow for fruit purpose in the limited gardens. However, some farmers do cultivate on commercial basis and generate income from its sale. It bears flowering during April and May fruiting in May and June and fruit harvest happening in the month of November and December normally.

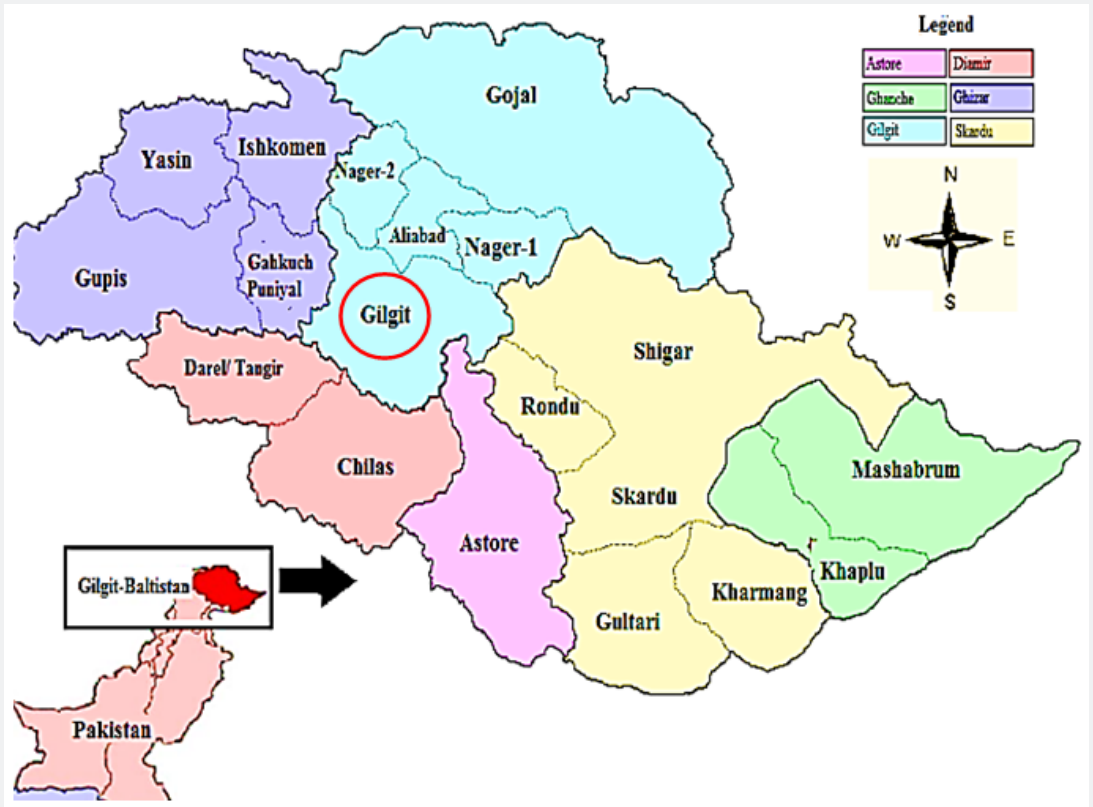

Figure 1: Map of gilgit (Study Area).

Sampling

Plant material

Plant material, which includes leaves and fruits, were collected through random sampling technique followed by a purposeful sampling. Each variety was identified, and samples were collected from ten plants of each variety from each village (Table 1). Ten leaves were extracted from different directions and heights of each plant. The same was exercised for fruit collection. Plant material so extracted was immediately transported to the laboratory at Biological Sciences Department, Karakoram International University Gilgit for further processing and data collection through their measurement.

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Table 1: Sample villages and geographic profile.

S.No.	Sample sites	Longitude (N)	Latitude (E)	Elevation (ft)
1.	Danyore	35° 55' 10.56"	74° 23' 16.87"	4936 ft
2.	Sultan Abad	35° 56' 35.05"	74° 22' 49.43"	4863ft
3.	Muhammad Abad	35° 54' 14.54"	74° 24' 30.94"	4971ft
4.	Diding Das	35° 53' 52.76"	74° 24' 39.16"	4860ft
5.	Jutel	36° 02' 18.97"	74° 17' 49.39"	5308ft

Household survey

A household survey was conducted randomly from the sample sites (villages mentioned in the table 3.1). A standard instrument was used to interview the household head to collect information required against each parameter mentioned here below. Ten households were interviewed from each village during survey. A total of fifty questionnaires were filled carefully. Following parameters were studied during the study Plant height, DBH, Age, Life span, Water Requirement, Fertilizer requirement, Medicinal Uses Flowering period, fruiting period, Harvesting period, Sale, Fruit consumption at home, Diseases Variety, Annual production, Fruit weight, Fruit diameter, Fruit height, Leaf Length, Leaf Width, Leaf weight, Per kg price.

Data collection

Data was collected through two different means i.e. plant material measurement which includes leaf, fruit, plant height and DBH. Leaf and fruit were measured in the laboratory using electronic balance and scales. Plant height and DBH was measured in the field using 'straight hand thump up' technique and with measuring tap respectively. Secondly, household survey was conducted using a structured questionnaire to ensure similarity and standardization of responses across study.

Data processing and analysis

Data gathered was digitized into Microsoft Excel spread sheets. Following its digitization, data was cleaned and prepared to transform into SPSS (Statistical Package for Social Sciences) Ver. 16. For analysis descriptive statistic including means, standard deviation, standard error and frequencies etc. were used to find the basic results. However, to deduce relationships among parameters inferential statistics has also been used i.e. cluster and hierarchical analysis to generate dendrograms and to find the genetic distances among the varieties.

Result

DBH, plant height and varietal profile

Persimmon population in the area has a mean Diameter at breast height was 78.59cm (Std. Error 7.70938, Std. Dev. 54.5136, Min 4.57-Max 304.8). More than 24% population falls in between 121.92 cm 101.6cm. Plant height reaches up to 25 feet (ft) above ground. Majority population consists upon 20.5ft (22%). There are three major varieties found in the area i.e. Hermit (86%) Jangly (12.0%) and Chocolate (2%). Mean life span recorded was 59.3 years (Std. Error 3.89927, Std. Dev. 27.57198, Min 30-Max 200).

Production, Sale, consumption and medicinal uses

On an average, a mature Persimmon tree bears 151.8kg (Std. Error, 14.64948 Std. Dev.103.58749, and Min 20 -Max 500). Two hundred kilogram producing population makes the majority (24 %) composition in the entire population. Out of total 64 % is sold at an average price of 13.2 Pak Rupees per kg (Std. Error 1.08879, Std. Dev.6.62283, Min. 0, and Max 35). Almost 25.65% is consumed at production site by the farmers (Std. Error 3.763, Std. Dev.25.521, Min 0-Max 100). Rest of 11.35% goes unattended and wasted annually.

Flowering, Fruiting, and harvesting periods

Flowering starts in April (80%) and May (20%). fruiting begins in May (82%) and June (18%). Similarly, harvesting commences in November (84%) and December (12%) (Figure 2).

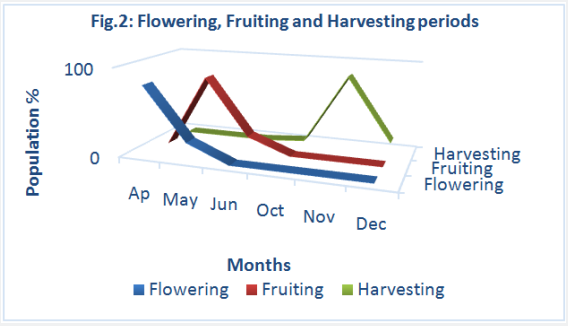

Figure 2: harvesting periods.

Management

Water and nutrient requirements

It was observed (78%) during survey that Persimmon requires low water and fertilizer. Rest of 20% farmers was with the opinion that it requires moderate supply of water and fertilizers.

Diseases profile

Study revealed that 78% of the plant population and its production is diseases free. Rest of 20% population suffers with diseases like borer attack, fungal attack and skin necrosis. Farmers never use any pesticide, fungicide and other control measures.

Leaf and fruit quantitative parameters

Average leaf length recorded was 11.59cm, mean leaf width was 7.74cm and average leaf weight was 0.82 g. Mean fruit height 4.2cm, means fruit diameter 6.0cm and average fruit weight 121.4g (Table 2).

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Table 2: Average Leaf and fruit length (cm).

Mean leaf parameters			
Statistics	Leaf length (cm)	Leaf Width (cm)	Weight /10 leaves (g)
Mean	11.57	7.74	0.8183
Std. Error of Mean	0.37	0.38	0.00449
Std. Deviation	2.62	2.70	0.03174
Minimum	9.02	5.00	0.73
Maximum	28.4	22.2	0.89

Mean fruit parameters		
Fruit height	**Diameter**	**Weight**
4.21	6	121.4
0.212	0.177	3.352
1.502	1.253	23.702
0.84	1.68	82.8
12.56	9.62	195.6

Genetic distance estimation

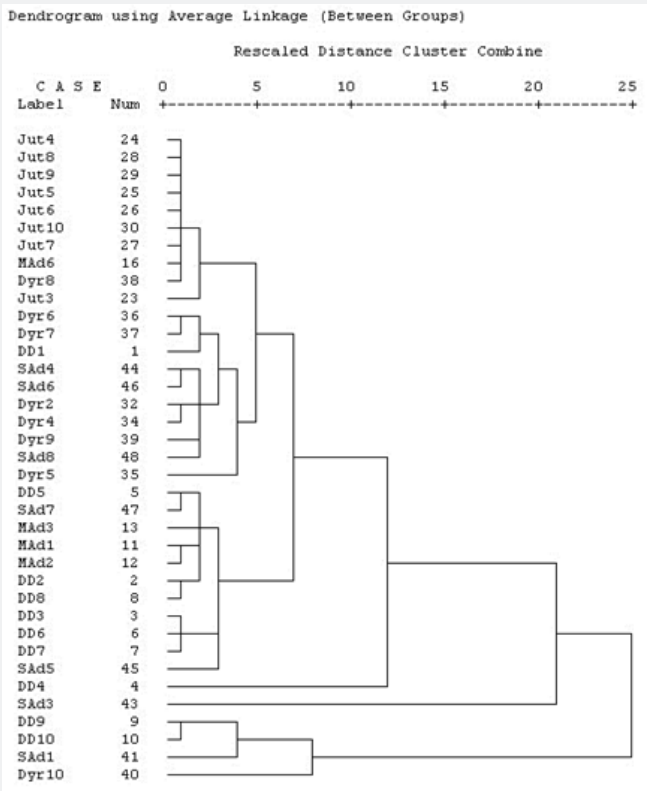

Figure 3: Dendrogram generated from cluster analysis.

Hierarchical clustering method assessment of numerical parameters viz. leaf length, leaf width, leaf area, DBH, fruit height, fruit diameter and weight revealed that there are at least three different varieties cutting tree at a distance point of 15 (rescaled, Figure 3). But, these classes and clusters do not create any synergy across different varieties mentioned and classified in the field by the farmer community.

Discussion

Genetic diversity defines the differences across genera and infra generic diversity among organisms and individuals. This helps in improving the genetic makeup of organisms through transfer of desirable genes making hybrids effective and resistant. Study was aimed at estimation of genetic diversity of Japanese persimmon varieties cultivated in Gilgit and its role in livelihood of local communities. Morphological markers have been used successfully for genetic diversity estimation in different species.

Hierarchical clustering analysis revealed that there is a great diversity across varieties. However, at genetic dissimilarity index of 15 these can be classified into three. Which is not natural because on its broader level i.e. in the field people identify them into three based on the morphological grounds. Uses of leaves and fruit morphological features are least reliable in case of Japanese persimmon. Contrary to the studies of several scientists including that Japanese persimmon has diverse ethno medicinal uses in different parts of the world is only used as fruit but there is no medicinal use in the area. However, if farmers are trained to add value and process for making different products then its commercial applicability will increase, and farmers can start growing and processing for different uses.

Conclusion

Study revealed that leaf, fruit and DBH quantitative parameters cannot be used towards any taxonomic classification. Presence of varieties including 'Chocolate – sample # 35 and Jungly – sample # 45'evident that being different varieties in the field show high similarity to other variety 'Hermit' rather than a distinct variety or varieties. This research suggestive that towards any discrimination or classification, only reproductive, DNA based classification and qualitative characters can be exploited. A complete value chain development programmed can establish on promotion of its value-added products and income generation.

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