International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(4): 1908-1914

Received: 10-05-2018
Accepted: 12-06-2018

Sukhjit Kaur
Assistant Horticulturist, Punjab Agricultural University, Regional Research Station, Gurdaspur, Punjab, India

Correspondence
Sukhjit Kaur
Assistant Horticulturist, Punjab Agricultural University, Regional Research Station, Gurdaspur, Punjab, India

Evaluation of fruit quality characteristics of four genotypes of loquat (*Eriobotrya japonica* Lindl.) under sub-montaneous conditions of Punjab

Sukhjit Kaur

Abstract
The pomological specifications of four new loquat genotypes *viz.* Benazir, Gola, Japani and Sufeda were evaluated at the experimental orchard of the Punjab Agricultural University, Regional Research Station, Gurdaspur. Significant differences were observed among the genotypes in terms of fruit length, fruit breadth, fruit weight, pulp weight, seed weight, peel weight, total soluble solids and acidity. The highest fruit length, fruit breadth, fruit weight, pulp weight, seed weight, peel weight were observed in Japani genotype. Highest number of seeds were observed in Gola and lowest in Japani genotype. Japani has highest pulp to seed ratio, but Gola has lowest pulp to seed ratio. Width/length index was highest in Japani and lowest in Sufeda genotype. TSS was highest in Gola and lowest in Sufeda genotype. Highest acidity was noticed in Sufeda (1.16%) and lowest in Gola (0.52%) genotype.

Keywords: Evaluation, fruit quality characteristics, genotypes, loquat (*Eriobotrya japonica* Lindl.), submontaneous conditions

Introduction
The loquat (*Eriobotrya japonica* Lindl.) is a species of evergreen flowering plant in the family Rosaceae, sub-family Pomoideae and it is sub-tropical fruit tree native to south-central China. Its cultivation has been recorded for more than 2000 years in Chinese history (Lin *et al*., 2007) [25], but now a days it is cultivated commercially worldwide. So far, loquat has been grown in over 30 countries in the world (Feng *et al*., 2007) [8]. China is the leading country in loquat cultivation followed by Spain and Japan (Lin *et al*., 2007) [25]. Loquat is mainly cultivated in China, Japan, Pakistan, India, Italy, Madagascar, Mauritius Island, the Mediterranean countries, United States, Brazil and Australia (Vilanova *et al*., 2001; Li *et al*., 2007) [39, 24]. Generally, loquat is grown between 20° and 35° North or South latitudes, however, it can be cultivated up to 45° latitudes (Lin *et al*., 1999) [26]. Well-established trees can tolerate a drop in temperature to -12° C (Demir, 1987) [4] and temperatures above 35°C may negatively affect tree growth (Jonathan *et al*., 2006) [22]. This fruit is introduced in India in the name of "Japanese medlar". In India, commercial cultivation of this fruit carried in the states of Uttar Pradesh, Punjab, Delhi, Assam, Himachal Pradesh and Maharashtra. In Punjab, it can be grown successfully in Gurdaspur, Hoshiarpur, Ropar, Patiala and Amritsar districts. Loquat fruit is delicious, with an attractive yellow colour, flavour, and high economic and medicinal value. Since it flowers in the autumn, it is a good source of nectar when other resources are scarce (Merino and Nogueras, 2003) [28]. Loquat fruit development takes place during winter and ripens at early spring. Due to its unusual phenology, it is available in the market before any other fruit of the spring season (Cuevas *et al*., 2007) [3]. Loquat fruit becomes available in the months of March/April when no other fresh fruit is available in the market, hence gives good returns. It is consumed mostly in the local markets or short distant markets.

Mainly loquat is used as fresh fruit. Besides being sweet and juicy, it is very nutritious. Loquat have sucrose, laevulose, malic acid and lower quantity of tartaric, citric, and succinic acid, minerals (phosphorous & calcium), vitamins (A, B & C), salts and various sugars (Karadeniz *et al*., 2003) [23]. Loquat cultivars have a variable range of total phenol content and high total antioxidant capacity, which is crucial for human health (Polat *et al*., 2010) [34]. Besides its nutritive importance, it is also useful for the medicinal properties. Fruit and leaves of loquat have been considered to have high medicinal value (Wee & Hsuan, 1992) [40].

In China and Japan, its leaves are used as therapeutic agents to inhibit inflammation and fibrosis (Yoshioka *et al*., 2010) [45] and are used to treat skin diseases and to relieve pain, inflammation (Nishioka *et al*., 2002) [30] and cough (Sakuramata *et al*., 2004) [37]. Leaves also contain antitumor agents (Ito *et al*., 2002) [19]. Loquat seed extract has an inhibitory effect on liver disorders (Yoshioka *et al*., 2010) [45]. The fruits are also commonly used to make jam, jelly, and chutney, and are often served poached in light syrup. Firm and slightly immature fruits of loquat are best for making pies or tarts. A detailed study of loquat genotypes may provide a base for the proper identification and preservation of local germplasm, which would be helpful in the establishment of orchards with uniform loquat plants of known cultivars (Hussain *et al*., 2009) [13]. Consumers choose loquat fruits for their excellent quality. Shape, colour, absence of skin defects, are very important to determine consumer's preference (Canete *et al*., 2007) [2]. Fruit weight, size, number of seed and flesh thickness are important fruit quality factors effecting the storage and marketing of the fruits (Fu *et al*., 2009) [10]. The purpose of this study was to study and evaluate the morphological and chemical quality of four loquats genotypes grown under sub-montaneous zones of Punjab conditions and to identify the superior genotypes may help to increase the production, hence increasing its availability for the domestic market as well as for export.

Materials and Methods

The evaluation of four loquat genotypes was conducted at the experimental orchard of the Punjab Agricultural University, Regional Research Station, Gurdaspur. The loquat germplasm *viz.* Benazir, Gola, Japani and Sufeda were planted at a distance of 6.5m × 6.5m in Randomized Block Design with three replications each and each replication having four plants per genotype. Bearing plants of these genotypes with almost same size and apparently good health were tagged to study their characteristics. Fruits were evaluated according to the pomological specifications as follows: fruit colour, pulp colour, fruit shape at basal end, fruit shape at apex, seed colour, seed shape, fruit length, fruit breadth, width length index, fruit weight, pulp weight, seed weight, peel weight, number of seeds, pulp/seed ratio, total soluble solids(TSS), acidity were determined.

Total soluble solids (TSS) of the juice was determined by hand refractometer. Titrable acidity was determined by the titration against (0.1N) NaOH (AOAC, 1981) [1]. Fruit length and fruit width were recorded with the help of 'vernier calipers'. Fruit width/length index was measured by dividing fruit width by fruit length. Fruit weight, pulp weight, peel weight and seed weight were measured with the help of electric balance by a precision scale of ±0.01g. Pulp/seed ratio was determined by dividing pulp weight by seed weight. Data was analysed statistically by Randomized Block Design as described by Singh *et al*., (1998) [38].

Results and Discussion

Significant differences were observed with reference to various pomological fruit quality characteristics among different genotypes of loquat (Table1&2).

Fruit skin colour, pulp colour, fruit shape, seed colour and seed shape

From Table 1, fruit skin colour was orange yellow in Benazir and Japani genotypes. Orange and yellow fruit skin colour were noticed in Gola and Sufeda genotype respectively. Pulp colour was yellowish orange, orange, yellow and yellowish white in Benazir, Gola, Japani and Sufeda respectively. Pear shaped fruit was observed in Japani and Sufeda. Obovoid and round fruit shapes were observed in Benazir and Gola respectively. Obtuse fruit shape at basal end was noticed in Benazir, Japani and Sufeda genotypes, but it was round in Gola genotype. Benazir, Japani and Sufeda had raised fruit shape at the apex, but it was flat in Gola genotype. Brown seed colour with elliptic seed shape was noticed in all the genotypes.

(Hussain *et al*, 2009) [13] observed that fruit skin colour was yellowish white in KK5, yellow in KK4, while orange yellow in the KK2, KK3, KK1, CS1, CS2 and CS3 genotypes. Yellowish white pulp colour was noted in KK4, CS1 and CS3, whereas other five genotypes i.e. KK1, KK2, KK3, KK5, CS2 had orange pulp. Overall fruit shape was round in KK3 and KK5, while oblong in KK2 and CS3. Other four genotypes i.e. KK1, KK4, CS1, CS2 had obovoid fruit. Fruit shape at the basal end in all the genotypes (KK1, KK2, KK3, KK5, CS1, CS2, CS3) was obtuse except in KK4 which was round. Fruit shape at the apex was flat in KK1 and CS3, depressed in KK4, while raised in all other genotypes (KK2, KK3, KK5, CS1, CS2). Brown seed colour was observed only in KK1 and CS3. On the other hand, all other genotypes (KK2, KK3, KK4, KK5, CS1, CS2) had light brown seed colour. Seed shape in all the genotypes (KK1, KK2, KK3, KK4, KK5, CS1, CS2, CS3) was elliptic.

In China, orange yellow skin and flesh colour has also been reported in Yangmeizhou 4 (Wu, 2001) [41], while orange skin and pulp colour has been observed in Kumquat loquat and Sour loquat (Huang *et al*., 2007) [12]. Ninghaibai has a yellowish white skin while the flesh colour is white with a long round or round fruit shape (Feng *et al*., 2004) [9]. In Spain, Magdal and Cardona cultivars have fruits with obovoid and oblong shape respectively, while shape of seeds in both the cultivars was reported to be elliptic (Llacer *et al*., 2003) [27].

Fruit skin colour was orange in HW1 and orange yellow in other genotypes (HW2, HW3, HW4, HW5). Pulp colour was orange in all the genotypes (HW1, HW2, HW3, HW5) except HW4 which had yellow pulp (Hussain *et al*., 2011) [16]. In Spain, orange yellow skin as well as pulp colour has been observed in a number of loquat varieties including 'Cardona', 'Algerie', and 'Golden Nugget'. 'Buenet' has orange skin and pulp colour (Llacer *et al*., 2003) [27]. In China, 'Hanwuzhong' cultivar has the same skin and pulp colour as in HW4 i.e., orange yellow and yellow respectively (He *et al*., 2007) [11]. Orange pulp colour has been observed in 'Kumquat loquat' and 'Sour loquat' (Huang *et al*., 2007) [12]. Hussain *et al*. (2011) [16] observed that genotypes (HW1, HW2, HW3, HW5) except HW4 had some other similarities among themselves including fruit shape (round), fruit shape at the apex (raised) and seed colour (light brown). HW4 had obovoid fruit shape, flat shape at the apex and brown seed colour. Fruit shape at the basal end was obtuse in HW1, HW2 and HW3, while round in other two genotypes (HW4, HW5). Seed shape was elliptic in all the five genotypes (HW1, HW2, HW3, HW4, HW5). Hussain *et al*. (2011) [16] reported that fruit shape of HW4 resembles with that of the loquat cultivars, 'Magdal' and 'Tanaka' in Spain, which have been reported to have obovoid shape of fruit and elliptical seeds. The other four genotypes *viz.* HW1,HW2,HW3 and HW5 have round fruits and elliptical seeds as has been observed in 'Saval-2' (Llacer *et al*., 2003) [27].

Fruit skin colour was yellow in TB5 and TB11, orange in TB13, yellowish white in TB8 and TB15, while orange

yellow in all other genotypes (TB1, TB2, TB3, TB4, TB6, TB7, TB9, TB10, TB12, TB14). Pulp colour was yellowish white in TB6, orange yellow in TB1, TB3, TB8, TB9 and TB15 while orange in all other genotypes (TB2, TB4, TB5, TB7, TB10, TB11, TB12, TB13, TB14). Fruit shape was oblong in TB1 and TB10, round in TB3 and TB4 but obovoid in all other genotypes (TB2, TB5, TB6, TB7, TB8, TB9, TB11, TB12, TB13, TB14, TB15). Fruit shape at the basal end was acute in TB1 and TB2, round in TB4, TB5, TB8 and TB15, whereas obtuse in the remaining genotypes (TB3, TB6, TB7, TB9, TB10, TB11, TB12, TB13, TB14). Fruit shape at the apex was raised in TB1, TB2, TB9, TB10, TB11 and TB14, depressed in TB3 and TB7, while flat in all other genotypes (TB4, TB5, TB6, TB8, TB12, TB13, TB15). Seed colour was brown in TB1 and dark brown in TB2. All other genotypes (TB3, TB4, TB5, TB6, TB7, TB8, TB9, TB10, TB11, TB12, TB13, TB14, TB15 had the seeds with light brown colour. Seed shape was round in TB4 and TB5, while elliptical in all the remaining genotypes (TB1, TB2, TB3, TB6, TB7, TB8, TB9, TB10, TB11, TB12, TB13, TB14, TB15) (Hussain *et al*., 2011) [17].

Fruit Length

Fruit length was also highest in Japani (5.60 cm) followed by Benazir (4.50 cm) and lowest in Gola (2.60 cm) with a significant difference (Table 2).

Durgac *et al*. (2006) [5] observed the highest fruit length value in 'Kanro' (44.35 mm), and lowest in 'Baffico' (33.84mm) genotypes of loquat. Hussain *et al*. (2009) [13] observed that the KK2 genotype of loquat was at the top with reference to fruit length (3.45 cm) and KK3 was at lowest (2.73cm). Fruit length was highest in CS2 (3.62 cm) loquat genotype which was followed by CS1 (3.52 cm) both being at par. CS3 had significantly low fruit length (3.03 cm). Hussain *et al*. (2011) [16] noted the maximum fruit length in HW2 (3.66 cm) followed by HW4 (3.62 cm) and HW3 (3.53 cm) genotypes of loquat, all the three being at par. Lowest fruit length with significant difference was noted in HW5 (2.87 cm). Hussain *et al*. (2011) [15] observed the highest fruit length in Tret4 (5.09 cm) followed by Tret2 (4.06 cm) genotypes of loquat with a significant difference. It was lowest in Tret5 (2.95 cm).Hussain *et al*. (2011) [17] recorded the maximum fruit length in TB15 (5.08cm) followed with non-significant difference by TB5 (5.04) genotypes of loquat. It was lowest in TB6 (2.88 cm) loquat genotype.

Fruit Breadth

Fruit breadth was also highest in Japani (4.30 cm) followed by Sufeda (3.60 cm) and lowest in Gola (2.0 cm) with a significant difference (Table 2).

Hussain *et al*. (2009) [13] reported that KK2 was at the top with reference to fruit width (3.15 cm) and lowest in KK4 (2.30cm) genotypes of loquat. Fruit width was significantly highest in CS2 (3.21 cm) followed by CS1 (2.70 cm). It was least in CS3 (2.64 cm) which was at par with CS1.

Hussain *et al*. (2011) [16] reported the maximum fruit width in HW4 (3.18 cm) followed by HW2 (2.90 cm) loquat genotype with a significant difference. Fruit width was significantly lowest in HW1 (2.53 cm). Hussain *et al*. (2011) [15] noted the highest fruit breadth in Tret4 (4.06 cm) followed by Tret2 (3.10 cm) and lowest in Tret5 (2.70 cm) genotypes of loquat. Hussain *et al*. (2011) [17] observed the highest fruit width (4.15 cm) in TB15, which was followed with a significant difference by TB8 and TB13 (both having 3.72 cm width) genotypes of loquat. Lowest fruit width was observed in TB2 (2.49 cm).

Fruit width/length index

From Table 2, Fruit width/ length index was found to be non-significant in all the genotypes.

Hussain *et al.*, (2009) [13] observed that KK5 had the highest width length index (1.06) followed by KK3 (0.99) loquat genotypes. Least fruit width (2.30 cm) as well as the width length index (0.77) was observed in KK4. Width length index was maximum in CS2 (0.89) followed by CS3 (0.87) and was significantly low in CS1 (0.77) genotypes of loquat. Hussain *et al*. (2011) [16] recorded the highest width length index in loquat genotype HW5 (0.89) followed by HW4 (0.88) both being at par. HW1 had the lowest width length index (0.77). Hussain *et al*. (2011) [15] noted the highest width length index in Tret5 (0.91) loquat genotype. It was followed with a significant difference by Tret1 (0.86) and Tret3 (0.86), later two being at par. Width length index was least in Tret 2 (0.76). Hussain *et al*. (2011) [17] observed the highest width length index in TB3 (0.93) followed by TB6 (0.88) and lowest in TB5 (0.71) genotypes of loquat.

Fruit Weight

Japani (45.54gm) genotype had highest fruit weight followed by Sufeda (36.6gm), however the lowest was that of Gola (22.05gm) with a significant difference (Table 2). Elsabagh and Haeikl (2012) [6] reported that highest fruit weight in Emanwil (44.45gm) and Yahoda (44.56gm) loquat cultivars, however the lowest was that of Akka (29.03gm) cultivar. In similar studies on loquat cultivars, fruit weight ranged from 19.7 to 47.2 gm (Polat and Caliskan, 2006) [33], 27.6 to 37.9 gm (Polat *et al*., 2010) [34]. In China Puxinben cultivar can produce fruits up to 58.1 to 77.1 gm (JianPing *et al*., 2002) [20]. Fruit weight observed in 'Zhaozhong' (30 gm), 'Jidanbai' (35.6gm) and 'Guangyu' (43.61gm), which are some of the prominent cultivars of China (Feng *et al*., 2007) [8].

'Qingbian', 'Hanwuzhong' and 'Mojia No. 1' in China have fruit weight of 28.70 gm, 30.97 gm and 53.20 gm respectively (He *et al*., 2007) [11]. Fruit weight of 'Magdal' and 'Crisanto Amadeo' in Spain has been observed as 45.50 gm and 68.70 gm respectively (Llacer *et al*., 2003) [27]. In Turkey, 'Ottawiani' and 'Dr. Trabut' have been found to have fruit weight of 49.78 gm and 43.23 gm respectively (Yalcin & Paydas, 1995) [43].

In Japan, 'Satomi' and 'Fusakikari' had fruit weight of 65gm and 75 gm respectively (Nakai *et al.,* 1990) [29]. 'Hongdenglong' in China (Jiang *et al*., 2001) [21], 'Algerie' in Spain (Llacer *et al*., 2003) [27], 'Nespolone di Trabia' in Italy (Insero *et al*., 2003) [18] and 'Ottawiani' in Turkey (Yalcin and Paydas, 1995) [43] were observed to have fruit weight of 63.1 gm, 65.0 gm, 50.40 gm and 49.78 gm respectively.

Fruit weight was maximum in Tret4 (38.77 gm) followed by Tret2 (20.04 gm) with a significant difference. Minimum fruit weight was recorded in Tret1 (12.73 gm) (Hussain *et al*., 2011) [15].

Its fruit weight of Tret4 (38.77 gm) was much higher than that of 'Dr. Trabut' with an average fruit weight of 29.54 gm (Durgac *et al*., 2006) [5] and 'Hanwuzhong' with a fruit weight of 30.97 gm (He *et al*., 2007) [11]. On the other hand, in Japan, leading loquat cultivars, 'Mogi', 'Nacasakiwase' and 'Tanaka' have average fruit weights of 50 gm, 60 gm and 70 gm respectively (Durgac *et al*., 2006) [5].

'Güzelyurt 1' had the highest average fruit weight (37.80gm), and 'Akko XIII' (20.20gm) the lowest (Polat and Caliskan,

2011) [35]. In similar studies of loquat cultivars, fruit weights ranged from 22.70 to 37.60 gm (Paydas *et al*., 1992) [32], 25.40 to 49.80 gm (Yalcin and Paydas, 1995) [43], 19.70 to 47.20gm (Polat and Caliskan, 2006b) [36], 27.6 to 37.9gm (Polat *et al*., 2010) [34]. In Japan (Nakai *et al*., 1990) [29] 'Satomi' and 'Fusahikari' had fruits as large as 65-70gm, in China 'Puxinben' can produce fruits up to 58.1-77.1gm (Jian Ping *et al*., 2002) [20].

Hussain *et al*. (2011) [17] reported the maximum fruit weight in TB15 (47.84gm) followed by TB8 (46.05gm) while lowest in TB2 (11.04gm).

Pulp Weight

Pulp weight was maximum in Japani (41.25gm) followed by Sufeda (32.90gm) with a significant difference. Minimum fruit weight was recorded in Gola (19.7gm) (Table2).

Edible portion was highest in 'HÇG' (83.8%) and lowest in 'Lapta M' 295 (74.3%) (Polat and Caliskan, 2011) [35]. In similar studies, edible portion of loquat ranged between 74.1 and 86.6% (Hussain *et al*., 2006) [14] and between 70 and 80% (Zhou *et al*., 2004) [46].

Seed Weight

Significant differences were observed among the genotypes with respect to the seed weight (Table 2). Maximum seed weight was observed in Japani (3.60gm) followed by Sufeda (3.10gm) and lowest on Gola (2.20gm) genotype (Table 2).

Total seed weight per fruit was highest in 'Dr. Trabut' (6.19gm) and lowest in 'Kanro' (4.0gm) (Durgac *et al*., 2006) [5] In the other studies from Spain and Italy, 'Gold Nugget' had 8.1gm (Llacer *et al*., 2003) [27] and 6.6gm (Insero *et al*., 2003) [18] total seed weight per fruit, respectively.

All the genotypes were significantly different among each other with respect to seed weight. Seed weight was highest in HW1 (1.38gm) followed by HW2 (1.28gm) while minimum in HW3 (0.98gm) (Hussain *et al*., 2011) [16].

The highest total seed weight was found in 'HÇG' (3.0gm) and the lowest in 'Lapta M' (1.3 gm) (Polat and Caliskan, 2011) [33].

Total seed weight per fruit was highest in KK2 (4.81gm) followed by KK1 (4.56gm) and KK5 (4.54gm), all the three genotypes having non significant difference. Total seed weight per fruit was lowest (3.39gm) in KK3 (Hussain *et al*., 2009) [13]. Weight per seed was maximum in CS2 (1.89gm) followed by CS1 (1.20gm) and minimum in CS3 (1.11gm). Similarly, total seed weight per fruit was highest in CS2 (6.18gm) and lowest in CS3 (3.78gm) (Hussain *et al*., 2009) [13]. Maximum seed weight (2.11gm) as well as maximum seed content/fruit (10.19gm) was also recorded in Tret4. Although Tret1 has been observed to have the lowest number of seeds/fruit (3.18) as well as the lowest seed content/fruit (3.95gm), it is not so attractive due to its smallest size and a low flesh seed ratio (Hussain *et al*., 2011) [15]. Seed content of two cultivars in Spain, 'Saval 2' and 'Peluches' has been reported to be 8.60gm and 11.20gm/fruit respectively (Llacer *et al*., 2003) [27] but they are considered excellent due to their larger fruits. (Hussain *et al*., 2011) [17] reported the single seed weight was maximum (2.41gm) in TB15 followed by TB12 (2.40gm), both being at par with each other. TB3 had the lowest seed weight (0.98gm). Total seeds' weight per fruit was maximum in TB15 (12.37gm) followed by TB8 (11.37gm), while minimum in TB2 (3.73gm).

Peel Weight

Highest peel weight was observed in Japani (0.69gm) followed by Sufeda (0.60gm) and lowest in Gola (0.15gm) genotype with a significant difference (Table 2).

Number of Seeds

Number of seeds were found to be non-significant in all the genotypes (Table 2).

Seed number is dependent upon pollination conditions and it is one of the discriminative characters for loquat cultivars. In this study, 'Kanro' (2.40 seeds per fruit) had the lowest seed number, which was followed by 'Baffico' (2.62 seeds per fruit). 'Dr. Trabut' had the highest seed number (3.59 seeds per fruit) (Durgac *et al*., 2006) [5]. Also, in other studies carried out in similar ecological conditions, 'Dr. Trabut' had the highest number of seeds with 4.33 (Erdogdu 1987) [7], 4.53 (Paydas *et al*., 1991) [31], and 6.16 (Yalcin & Paydas, 1995) [43] seeds per fruit, respectively. In different ecological conditions, 'Gold Nugget' had 3.2 seeds per fruit in Spain (Llacer *et al*., 2003) [27] and 3.5 seeds per fruit in Italy (Insero *et al*., 2003) [18].

Elsabagh and Haeikl (2012) [6] reported another important factor affecting fruit quality in loquat is number of seeds. Superior quality fruits having fewer seeds. Number of seeds depends on pollination and cultivar.

Hussain *et al*. (2009) [13] reported the maximum number of seeds per fruit was observed in KK2 (3.63) followed by KK3 (3.45), both genotypes being statistically at par with each other. Lowest number of seeds per fruit was observed in KK5 (2.14).

Algerie in Spain had 2.30 seeds per fruit (Llacer *et al*., 2003) [27], which is slightly higher than that observed in KK5 (2.14), while in China, 'Taicheng 4' (Xie *et al*., 2007) [42] and 'White loquat' (Huang *et al*., 2007) [12] were reported to have only 1.32 and 2 seeds per fruit respectively. Hussain *et al*. (2011) [16] reported the highest number of seeds per fruit was observed in HW3 (4.69) followed by HW4 (3.85) with a significant difference. This number was the lowest in HW1 (2.99). In Italy, 'Algarie' variety has 4.10 seeds per fruit and average seed content per fruit is much higher (7.90 g) than the above genotypes. But the fruit weight of Algarie (57.70 g) is more than three times the weight of HW4 (Insero *et al*., 2003) [18]. 'Crisanto Amadeo' and 'Buenet' in Spain had 3.60 and 2.50 seeds per fruit, respectively (Llacer *et al*., 2003) [27]. In China, 'Taicheng 4' (Xie *et al*., 2007) [42] and 'White loquat' (Huang *et al*., 2007) [12] were reported to have only 1.32 and 2 seeds per fruit, respectively.

Polat and Caliskan (2011) [35] reported that 'Akko XIII' (2.1) had the least number of seeds/fruit, and 'Ottowianni' (4.1) had the most seeds per fruit. This is similar to the findings found in Adana (Paydas *et al*., 1992; Yalcin and Paydas, 1995) [32, 43], and in other studies at Hatay (Polat and Caliskan, 2006b; Polat *et al*., 2010) [36, 34].

Maximum number of seeds per fruit was observed in CS1 (3.64) followed by CS3 (3.39) with a significant difference. CS2 had the lowest number of seeds per fruit (3.28) and was at par with CS3 (Hussain *et al*., 2009) [13].In Italy, 'Selezione 2 PA', 'Nespolone di Trabia' 'Ferdinando' and 'Vainiglia' were observed to have 3.2, 3.8, 3.4 and 3.7 seeds per fruit respectively (Insero *et al*., 2003) [18].

Tret4 had the highest number of seeds/fruit (4.83) followed by Tret2 (4.23). Least number of seeds / fruit was observed in Tret1 (3.18) (Hussain *et al*., 2011) [15]. In Turkey, 'Kanro' 'Baffico' and 'Gold Nugget' had 2.40, 2.62 and3.0 seeds/fruit respectively (Durgac *et al*., 2006) [5]. In China, 'Niuteibaisha' cultivar had 2.78 seeds/fruit (Feng *et al*., 2007) [8].

Number of seeds per fruit was maximum in TB15 (5.13), followed by TB8 (4.88) with a significant difference. TB6 had the lowest number of seeds per fruit (3.32) (Hussain *et al*., 2011) [17].

Pulp to seed ratio

From Table2, Flesh to seed ratio was found to be non-significant in all the genotypes.

High flesh to seed ratios were observed in 'Cardona', Buenet', 'Peluches' and 'Tanaka' (6.20, 7.08, 7.48 and 5.38 respectively) in Spain (Llacer *et al*., 2003) [27].

Flesh seed ratio in CS1 (2.49) was very low as compared with that of 'Selezione 2 PA' (4.8), 'Ferdinando' (5.3) and 'Algerie' (6.2) as observed in Italy (Insero *et al*., 2003) [18], 'Kanro' (5.42) and 'Bafico' (4.16) as noted in Turkey (Durgac *et al*., 2006) [5]. In Spain 'Cardona', Buenet', 'Peluches' and 'Tanaka' were observed to have high flesh seed ratios of 6.20, 7.08, 7.48 and 5.38 respectively (Llacer *et al*., 2003) [27]. In Turkey, 'Baffico', 'Gold Nugget' and 'Kanro' were found to have a flesh seed ratio of 4.16, 3.83, and 5.42 respectively (Durgac *et al*., 2006) [5].

Total Soluble Solids (TSS)

Maximum TSS was observed in Gola (20.85°Brix) followed by Japani (18°Brix) and minimum TSS was noticed in Sufeda (12.5°Brix) genotype (Table2).

Durgac *et al.*, (2006) [5] reported total soluble solid(TSS) content of the cultivars varied between 9.09% ('Kanro') and 11.77% ('Baffico').

It is reported that 'Gold Nugget' had 11.2% TSS content in Italy (Insero *et al*., 2003) [18], and 11% in Spain (Llacer *et al*., 2003) [27]. Elsabagh and Haeikl (2012) [6] reported that total soluble solid (TSS), differ significantly among different genotypes. Zekeim had the highest TSS (13.22%) in 2011 and 11.89% in 2012, however the lowest was that of Akka (10.18%) in 2011 and the Yahoda (10.46%) in 2012. Polat and Caliskan (2011) [35] reported the total soluble solid (TSS), content of fruit were between 14.2% ('Lapta 1') and 8.7% ('Akko XIII').

Acidity

Maximum acidity was noticed in Sufeda (1.16%) followed by Benazir (0.94%) and minimum acidity was observed in Gola (0.52 %) genotype (Table2).

Durgac *et al*. (2006) [5] reported that the acidity of the cultivars varied between 0.73% ('Dr. Trabut') and 0.88% ('Kanro'). The acidity contents in the study were lower than the results of Erdogdu (1987) [7], Paydas *et al*. (1992) [32], and Yilmaz *et al*. (1995) [44] but higher than the results of Yalcin & Paydas (1995) [43]. Elsabagh and Haeikl (2012) [6] reported the total acidity was highest in fruits of Yahoda cultivars (0.122%), however the lowest was that of Emanwil cultivar (0.07% in 2011 and 0.047% in 2012) in both seasons. Polat and Caliskan (2011) [35] reported the total acidity was between 0.53% ('Akko XIII') and 1.16% ('Sayda').

Conclusion

From the present experiment it can be concluded that a good cultivar of loquat should be large in size, good colour, sweet, pulpy, sub-acidic, and juicy and should possess as few seeds as possible. Japani and Gola were shown to be suitable cultivars depending on their superior fruit quality.

Table 1: Fruit and seed morphology of four genotypes of loquat

Genotype	Fruit skin colour	Pulp colour	Fruit shape	Fruit shape at basal end	Fruit shape at apex	Seed colour	Seed shape
Benazir	Orange yellow	Yellowish orange	Obovoid	Obtuse	Raised	Brown	Elliptic
Gola	Orange	Orange	Round	Round	Flat	Brown	Elliptic
Japani	Orange yellow	Yellow	Pear shaped	Obtuse	Raised	Brown	Elliptic
Sufeda	Yellow	Yellowish white	Pear shaped	Obtuse	Raised	Brown	Elliptic

Table 2: Fruit quality characters of four genotypes of loquat

Genotype	Fruit length (cm)	Fruit breadth (cm)	Width/ length index	Fruit weight (gm)	Pulp weight (gm)	Seed weight (gm)	Peel weight (gm)	Number of seeds	Pulp /seed ratio	TSS (°Brix)	Acidity (%)
Benazir	4.50	3.20	0.72	30.11	27.00	2.82	0.29	4.21	9.57	14.20	0.94
Gola	2.60	2.00	0.76	22.05	19.70	2.20	0.15	4.31	8.95	20.85	0.52
Japani	5.60	4.30	0.77	45.54	41.25	3.60	0.69	3.20	11.49	18.00	0.75
Sufeda	5.00	3.60	0.72	36.60	32.90	3.10	0.60	4.00	10.74	12.50	1.16
CD (5%)	1.21	0.55	NS	4.09	3.99	0.59	0.21	NS	NS	2.94	0.11

References

1. AOAC. Association of official Agriculture chemists. Official methods of analysis, Washington DC. USA, 1981, 490-494-510
2. Canete ML, Pinillos V, Cuevas J, Hueso JJ. Sensory evaluation of the main loquat cultivars in Spain.Proc. II International Symposium on Loquat.Guangzhou, China1-5April, 2006. Acta Horticulturae. 2007; 50:159-163.
3. Cuevas J, Romero IM, Fernandez MD, Hueso JJ. Deficit irrigation schedules to promote early flowering in 'Algerie' loquat. 2nd Int. sympo on loquat. Acta Horticulturae. 2007; 750:281- 286.
4. Demir S. Loquat Growing. Citrus Research Institute of Forestry and the Ministry of Agriculture, Antalya. 1987; 12:30.
5. Durgac C, Polat A, Kamiloglu O. Determining performances of some loquat (*Eriobotrya japonica*) cultivars under Mediterranean coastal conditions in Hatay, Turkey. New Zealand Journal of Crop and Horticultural Science. 2006; 34(3):225-230
6. Elsabagh AS, Haeikl AM. Fruit Characteristics Evaluation of Four new loquat genotypes grown in Egypt. Research Journal of Agriculture and Biological Sciences. 2012; 8(2):197-200
7. Erdogdu H. Investigations on phenological and pomological characteristics of some local and foreign loquat cultivars. Unpublished MSC thesis, University of Çukurova, Institute of Natural Science, Adana, Turkey, 1987.

8. Feng JJ, Liu Q, Wang XD, Chen JW, Ye JD. Characterization of a new loquat cultivar 'Ninghaibai'. 2nd International symposium on loquat. Acta Horticulturae. 2007; 750:117-124.
9. Feng JJ, Wang XD, Liu Q, Zhang W, Ye JG. A new special middle-ripening loquat variety - 'Ninghai Bai'. Agricultural and Forestry Bureau of Ninghai County, Zhejiang 315600, China. Acta Horticulturae Sinica. 2004; 31(2):279.
10. Fu X, Li J, Zhou Y, Ying Y, Xie L, Niu X *et al*. Determination of soluble solid content and acidity of loquats based on FT –NIR spectroscopy. Journal of Zheijang University SCIENCE B, 2009; 10:120-125.
11. He XL, Lin SQ, Yang XH, Hu YL, Hu GB, Bu JH. Resources of Eriobotrya in Guangdong, China. 2nd International. Symposium on loquat. Acta Horticulturae. 2007; 750:197-202.
12. Huang GX, Pan JC, He XL, Yang XH, Lin SQ. A preliminary report of investigation on genus Eriobotrya Plants in Guangxi and their characteristics. 2nd International Symposium on loquat. Acta Horticulturae. 2007; 750:101-105.
13. Hussain A, Abbasi NA, Hafiz IA, Akhtar A. Morpho-physical characteristics of eight loquat genotypes cultivated in Chakwal district, Pakistan. Pakistan Journal of Botany. 2009; 41(6):2841-2849
14. Hussain A, Abbasi NA, Akhtar A. Fruit characteristics of different loquat cultivated in Pakistan. Acta Horticulturae. 2006; 750:287-289.
15. Hussain A, Abbasi NA, Hafiz IA, Zia ul Hasan S. A comparative study of five loquat genotypes at Tret, Murree,Pakistan. Pakistan Journal of Botany. 2011; 43(5):2503-2505
16. Hussain A, Abbasi NA, Hafiz IA, Zia ul Hasan S. A comparison among five loquat genotypes cultivated at Hasan Abdal and Wah. Pakistan Journal of Agricultural Sciences. 2011; 48(2):103-106
17. Hussain A, Abbasi NA, Hafiz IA, Shakoor A, Naqvi SMS. Performance of Loquat (*Eriobotrya japonica*) genotypes under agro-ecological conditions of Khyber Pakhtunkhwa province of Pakistan. International Journal of Agriculture and Biology. 2011; 13:746-750.
18. Insero O, Rega P, De Luca A. Comparison among ten loquat cultivars in Campania area. In: Llacer G and Badenes ML (eds.). Proceeding of First International Loquat Symposium, 11-13April 2002, Valencia (Spain).Options Mediterraneennes Serie A Seminaires Mediterraneens. 2003; 58:67-70.
19. Ito H, Kobayashi E, Li SH, Hatano T, Sugita D, Kubo N *et al*. Antitumor activity of compounds isolated from leaves of *Eriobotrya japonica*. Journal of Agricultural and Food Chemistry. 2002; 50:2400-2403.
20. Jian Ping P, GuoQiang L, GuoCheng X, ZhenMing C, ZongQi C. Puxinben, a new high quality and large-fruited loquat variety. South China Fruits. 2002; 31:27.
21. Jiang QL, Wang HM, Bai TX, Zhang HG. Hongdenglong, a late loquat variety. South China Fruits. 2001; 30:27.
22. Jonathan H, Crane H, Lilia CM. Loquat Growing in the Florida Home Landscape. University of Florida IFAS Extension, 2006, 18.
23. Karadeniz T. Loquat (*Eriobotrya japonica* Lindl.) growing in Turkey. First International Symposium on Loquat, 11-13 April 2002, Valencia (Spain). Options Mediterraneennes. Serie A. Seminaires Mediterraneens 2003; 58:27-28.
24. Li JQ, Hou CX, Luo N, Deng QX, Wang YQ. Direct embryogenesis from another culture of loquat.2nd International Symposium on loquat. Acta Horticulturae. 2007; 750:209-213.
25. Lin S, Huang X, Cuevas J, Janick J. Loquat: An ancient fruit crop with a promising future. Chronica Hort. 2007; 47:12-15.
26. Lin S, Sharpe RH, Janick J. Loquat: botany and horticulture. Horticultural Reviews. 1999; 23:233-276.
27. Llacer G, Badenes ML, Calvo JF. Plant material of loquat in Mediterranean countries. In: Llacer G and Badenes ML (eds.). Proceeding of First International Symposium on Loquat. 11-13 April, 2002, Valencia, Spain. Options Mediterraneennes Serie A Seminaires Mediterraneens 2003; 58:45-52
28. Merino N, Nogueras I. Loquat as a winter nectar source for birds in central Spain. Ardeola 2003; 50:265-267.
29. Nakai S, Yahata S, Morioka S. Characteristics of new loquat (*Eriobotrya japonica* Lindl.) cultivars 'Satomi' and 'Fusahikari'. Bulletin of the Chiba Horticultural Experiment Station 1990; 4:1-7.
30. Nishioka Y, Yoshioka S, Kusunose M, Cui TL, Hamada A, Ono M *et al*. Effects of extract derived from *Eriobotrya japonica* on liver function improvement in rats. Biological and Pharmaceutical Bulletin. 2002; 25:1053-1057.
31. Paydas S, Kaska N, Gubbuk H. Adaptation of some local and foreign loquat (*Eriobotrya japonica* Lindl.) cultivars under Adana ecological conditions (1987-1989 periods). Journal of Horticulture Faculty of Çukurova University. 1991; 6(2):17-26.
32. Paydas S, Kaska N, Polat AA, Gubbuk H. Adaptation of some local and foreign loquat cultivars to Adana ecological conditions (Experimental years 1990-1991). In: Turkish First National Horticultural Congress, İzmir, Turkey. 13-16 October. (in Turkish), 1992, 509-513
33. Polat AA, Caliskan O. Growth and fruit quality of some foreign loquat cultivars in the subtropical climate of the Turkish Mediterranean region. Journal of the American Pomological Society. 2006; 60:169-177.
34. Polat AA, Caliskan O, Serce S, Saracoglu O, Kaya C, Ozgen M. Determining total phenolic content and total antioxidants capacity of loquat cultivars grown in Hatay. Pharmacognosy Magazine. 2010; 6:5-21.
35. Polat AA, Caliskan O. Fruit Quality and Yield Characteristics of Some Loquat Genotypes in Dortyol, Turkey. Proceeding of IIIrd International Symposium on Loquat Eds.: Janick J and Aytekin Polat A. Acta Horticulturae. 2011; 887:293-298
36. Polat AA, Caliskan O. Growth and fruit quality of some foreign loquat cultivars in the subtropical climate of the Turkish Mediterranean region. Journal of the American Pomological Society. 2006b; 60:169-177.
37. Sakuramata Y, Oe H, Kusano S, Aki O. Effects of combination of Caiapo Reg. with other plant-derived substance on anti-diabetic efficacy in KK-Ay mice. Bio Factors. 2004; 22:149-152.
38. Singh S, Bansal ML, Singh TP, Kumar P. Statistical Methods for Research Workers. Kalyani Publishers, New Delhi, 1998.
39. Vilanova S, Badenes ML, Martinez-Calvo J, Llacer G. Analysis of loquat germplasm (*Eriobotrya japonica*

Lindl.) by RAPD molecular markers. Euphytica, 2001; 121:25-29
40. Wee YC, Hsuan K. An illustrated dictionary of Chinese Medicinal Herbs. GRC5 Pub. Box 1460, Sebastopol, CA, 1992.
41. Wu AH. "Yangmeizhou 4", a hardy and high quality new loquat variety. Department of Agriculture, Anyi County, Jiangxi, China. South-China-Fruits. 2001; 30(3):34-35.
42. Xie HJ, Chen D, Jiang JL, Wu HZ. Introduction of loquat to the Panxi region of China. 2nd International Symposium on loquat. Acta Horticulturae. 2007; 750:71-76.
43. Yalcin H, Paydaş S. Adaptation of some local and foreign loquat (*Eriobolrya japonica* Lindl.) cultivars to Adana ecological conditions (Experimental years 1995). In: Turkish Second National Horticultural Congress. Adana, Turkey 3-6 September. (in Turkish) 1995; 1:648-652
44. Yilmaz H, Sen B, Ayanoglu H. Adaptation of some loquat (Eriobolrya japonica Lindl.) cultivars under Erdemli Ecological conditions. 2nd Turkish National Horticultural Congress 1995; 1:638-642.
45. Yoshioka S, Hamada A, Jobu K, Yokota J, Onogawa M, Kyotani S *et al*. Effect of *Eriobotrya japonica* seed extract on oxidative stress in rats with non-alcoholic steatohepatitis. Journal of Pharmacy and Pharmacology. 2010; 62:241-246.
46. Zhou ZH, Jiang XJ, Wen XD, Deng XY, Luo XF. Investigation on the growth and bearing habit of Dawuxing loquat cultivar. South China Fruits, 2004; 33:40-41.