# Physicochemical and Organoleptic Characteristics of Loquat Fruit and Its Processing

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**Abstract:** Loquat (*Eriobotrya japonica* Linda L) is a fruit with high market value in Egypt with little details about its quality characteristics. The physicochemical characteristics of loquat fruit indicated that it contained higher total soluble solids 11.0 Brix, lower Ascorbic acid and can be considered as a good source of β-carotene. Brix lower ascorbic acid, loquat can be considered as a good source of B-carotene. Loquat fruit gave 86.32%, moisture, 5.53 mg/100g ascorbic acid and is a good source of mineral like phosphorus, iron, potassium, magnesium and calcium. Processed products jam; jelly and juice were prepared and assessed for their nutritive quality and acceptability.Results indicated That total soluble solids of jelly, jam and juice were 15, 76 and 13 Brix, respectively and that loquat juice contained more amount of ascorbic acid (4.28 mg\100g) and B –carotene (9.75 µg\100g) compared to jelly and jam. Sensory evaluation of processed products showed good acceptability. Loquat jam had higher for color and flavor while loquat juice taste and consistency recorded highest total score.

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**Key words:** Loquat, Physiochemical, Organoleptic, Jam, Jelly, Juice

## 1. Introduction

The loquat *(Eriobotrya japonica* Lindl.), a fruit in the *Rosaceae* family, originated in China and has been widely cultivated for commercial purposes since the 19th century. Currently, the main loquat producers are China and Spain producing 200,000 and 42,000 tons, respectively, each year. In Brazil, loquat production is concentrated in the state of *Sao* Paulo, mainly in the city of Mogi das Cruzes. In spite of being lower than in the primary production countries, the Brazilian production of this crop has a significant potential for expansion due to favorable climatic conditions.

This species adapts very well in temperate and subtropical areas requiring an average temperature of about 20°C. The loquat is agriculturally labor-intensive and sensitive to strong winds, but it responds well to irrigation and adapts well to different soils, as long as the soil is well-drained. The propagation of the loquat tree can be done using seeds or seedlings grafted onto another loquat tree or a quince tree (Patricia *et al.,* 2010).

The loquat is classified as a non-climacteric fruit since no respiratory peaks of ethylene are registered either from the attached fruit or after harvest. They detected a significant production of ethylene during the ripening for five Spanish loquat cultivars. This observation may have contributed to the re-classification of the loquat as a climacteric fruit by some authors. In other words, the classification of loquat is controversial.

During ripening, many metabolic changes in the fruit lead to the development of color, texture, and flavor making the fruit acceptable to consumers and subsequently establishing the nutritional and sensorial quality, as well as the shelf-life of the fruit.

Unripe loquat fruit is green and changes to orange or yellow once it ripens. The predominant organic acid in the green fruit is malic acid, which accounts for 90% of all acids together with small amounts of citric, succinic, furmaric, tartaric, and ascorbic acid .During ripening, the concentration of these organic acids decreases because they are used as a source of energy for respiratory metabolism, and they also may be used as a source of carbon for the production of sugars, which contributes to the sweetness of the fruit. In the loquat, the main sugars that accumulate during ripening are glucose, fructose, sucrose, and sorbitol. Galactose has also been found in small quantities (next to 0.1%) (Patricia *et al.,* 2010). The pulp of the loquat also contains carotenoids (mainly (β-carotene and β-cryptoxanthin), vitamins B I and B2, and nicotinamide (Souci et*al*., 1994and Patricia *et al.,* 2010).

The textural changes of the fruit are characterized by the softening of the pulp due to alterations in the molecular structure of the cell wall and middle lamella (BRUMMELL, 2006). The loss of firmness of the fruit is a problem in harvested loquats because this increases their susceptibility to injuries and deterioration of quality.

Loquat cultivars are classified commercially according to pulp color as either orange or white.

In Brazil, more precisely in *Sao* Paulo State, the most commonly commercially cultivars are the *Mizuho, Precoce de Itaquera,* and *Fukuhara* loquat cultivars (Patricia *et al.,* 2010). Other cultivars may also be found, such as *Mogi, Centenciria* (IAC 1567-420), *Mizunno (IAC 1567--111), Mizauto (IAC 167-4),* and *Nectar de Cristal (IAC 866-7).* The last four cultivars were developed by the Instituto Agronomico de Campinas – IAC (Agronomical *Institute of Campinas),* Sao Paulo State, Brazil as part of a genetic breeding program using classical hybridization protocols.

These new loquat varieties cultivated in Brazil were selected and developed because of their production potential, preferential resistance to disease, low susceptibility to mechanical damage, and low incidence of purple stain, a blemish, similar to sunburn, which affects the epidermis and harms the general appearance of the fruit. However, additional information about these cultivars is lacking.

Egypt is well known for its excellent climate, fertile land, adequate water for irrigation and wide variety of soils as well as a dynamic human resource.

These favorable characteristics permit the cultivation of almost all species of fruit trees known to the world, except those that have high chilling requirements. In 1993 the acreage cultivated was about 80 feddans (33ha) and the production was about 450 tons. Loquat is not widely known in Egypt, trees are propagated either by seeds or by grafting on loquat or quince root tocks.

Varieties grown in Egypt are: Early Suckary, Large Round, Advance, Premier & Late Victoria and they appear on market in March & April (Mansour *etal*., 1993)

Loquat has been used as medical plant in japan and china. The fruit act as sedative also can stop vomiting and prevent thirst. Astringent leaves of loquat have been used for a long time to treat chronic bronchitis, cough, phelgan, high fever and gastro enteric disorders. Trepenoids isolated from loquat leaves have anti-tumor, antiviral & anti immflamatory effect (Kim *et al.,*2009)

Loquat may be eaten fresh without the peel, combined with other fruit in fruit salads, used as a pie filling and made into sauces and gelatin desserts, jam & jellies (Jonathan et *al*., 2009).

High quality Loquat fruit have soluble solids content >12% moderate titratable acid (TA) from 0.3 to 0.6% and low flesh firmness (Singh et *al*., 2010).

They reported that bioactive components include flavonoids ,Triterpenig acids (Godoy and Amaya,1995), and carotenoids (JU et *al*.,2003). Also, the fruit contaied sugars : levulose and sucrose, citric, malic acid and lesser amounts of tartaric and succinic acid. The pulp contain the carotenoids B-carotene (33%),y-carotene (6%),cryptoxanthin (22%), lutein violaxanthin , neoxanthin (3-4% each). The peel is 5 times richer than the pulp in carotenoids which are similar to those in apricots (Park *et al.,* 2005)

The principle objectives of the economic exploration o loquat is the production of its fruits which can be eaten fresh or processed into jam and jelly (Federicoet*a*l., 2009). Jam, jelly and juice are usually produced by entrepreneurs and often encounter quality problems and do not meet the standard for these products. It is of utmost important that a manufacture must understand the scientific basis for producing a superior product which must meet the fundamental characteristics like PH, TSS ,total sugar and viscosity to ensure the standard excellence of the product (Muhammed *eta*l.,2011)

The overall production is steadily increasing. Several countries, such as Spain, Brazil, and India, are expected to increase commercial plantings of this crop. An interesting commercial aspect of loquat is that it ripens in early spring before other fruits (cherries, apricots, peaches, and plums) appear in the market. The most important problems (physiological and disease) result in a damaged fruit rind, which downgrades the fruit quality. Also, there is a need to reduce the labor costs of hand thinning and manual harvesting.

Therefore, this research was aimed to evaluate the physicochemical characteristics of loquat fruit grown in Egypt, as well as a comparative study of some of its processed products.

## 2. Materials and Methods

### 2.1. Material:

Loquat fruit was obtained from Giza local market ,Egypt.

**Chemical analysis:**

Loquat fruit was analysed its content of moisture, protein , fat , ash , carbohydrate , Ascorbic acid , TSS and pH were determined according to the method described in AOAC (2005).

**Color evaluation:-**

Loquat , jelly , jam & juice samples. Color difference were measured by using a spectrometer ( Tristimulus color machine) with CIE lab color scale (hunter lab scan XE reston VA).the instrument was equipped with a measuring head sensor connected to a computer. The instrument was calibrated using a standard white tile (X=77.26, Y=81.94 and Z=88.14) L*=92.66, a*=.86 ,b*=.16. the color was measured in terms of redness a* yellowness b* and lightness L*

**Carotenoid analysis**

The carotenoids were exhaustively extracted from the pulp (10 to 15 g) using acetone , transferred to petroleum ether (30-70 °C)/diethyl ether (2:1), and saponified overnight at room temperature with 10%

methanolic KOH. The alkali was fully removed by washing with water, and then the solvent was entirely evaporated in a rotary evaporator (Temp. <40°c) (DE R0sso &Mercadant, 2007) and Paticia et *al*.,2010). The major carotenoids were quantified using HPLC.

**Sensory evaluation and statistical analysis :-**

Appearance ,color, flavor ,taste& consistency of loquat fruit processed products i.e. jelly, jam and juice samples were evaluated organoleptically as described by( Meligaard *et al.,*1991) the result were statistically analyzed by the analysis of variance and least significant difference(LSD) at .05 level as reported by (McClave and Benson.,1991).

**Mineral content:**

Minerals content was determined by digestion of the samples with sulphric acid & percholic acid conc. (0.3ml)according to the method of Pearson (1991) and using Perkin Elmer 2380, atomic absorption spectrophotometer according to the method described in AOAC (2005) phosphorus content was also determined spectrophotometer as described by AOAC (2005)

**Preparation of jelly:**

The method of ( Lewandowiez *et al.,*2003) was employed for the preparation of jelly samples. The mixture composed of 60g for gelatin,100g sucrose and 500 ml of loquat was boiled under condition agitation for 180s , then acidified with 2g of citric acid, the obtained dessert was poured into a cup and allowed to set at room temperature for 2hrs.

**Preparation of jam:**

The method of Dawney *et al.*, (2002) was employed for preparation of Jam sample. Ripe loquat fruits were washed shopped into small pieces and de-stone. Fruit pieces were boiled with addition of 1 liter of water to 2 kg fruit pieces for few minutes to soften the fruit. Added 725gm sugar/kg fruit to blanched fruit and mix well. Heat, gently at fruits and increase the heat and boil the mixture to 65° Brix. Cool to about 82-85°F and fill into clean sterilized jars.

**3. Results and Discussion**

**3.1. Chemical composition of loquat fruit:**

Loquat fruit was chemically analyzed of its content of moisture, protein, fat, ash, carbohydrate ascorbic acid, TSS and pH as shown in table (1). Results in table (1) showed that the moisture content of fresh loquat fruit was 86.32% which may be one of the most important parameters for the fruit processing, mainly for Jellies and Jams preparation-high total soluble solids (Table 1) was 11.0 Brix indicating the presence of other compounds that may include vitamins, phenolics, pectin dissolved in fruit juice (Patricia *et al.,* 2010). Results also showed lower content of Vit. C. (ascorbic acid) in comparison with other fruits rich in vit, such as organes and charries that contain about 40-1005 g/100gm, respectively.

On the other hand, β-carotene, β-Cryptoxanthin ratio was 2.0, with high β-carotene 9.8 µg/g , and low β-Cryptoxanthin 4.0 µg/g.

The variation of these β-carotene results was due to loquat varieties, and, or loquat content of vitamin A which is an important nutrient for human health (Elif et *al*., 2008).

Acidity of loquat fruit (as malic acid) was 4.32% which could be directly related to the concentration of fruit organic acid that is an important parameter in maintaining the quality of fruits. This results is in agreement with that reported by (Attiq et *al.,* 2010) being 90% (malic acid) of the total oraganic acid in loquat fruit.

While total carbohydrate of loquat fruit was 13.25%, fat 0.21%, protein 0.51% and ash 0.34% these results suggest that the fruit can be indicated for in nature consumption, the highest content of water, ascorbic acid, TSS.

**Table (1): Chemical composition of loquat fruit**

| Constituent | LoquatMean±SD | Constituent | Loquat Mean±SD |
|---|---|---|---|
| Carbohydrates % | 13.25±0.36 | pH (as malic acid) | 4.32±0.41 |
| Fat % | 0.21±0.04 | B-carotene (µg/g) | 9.81±0.64 |
| Protein % | 0.51±0.11 | B-cryptoxanthin (µg/g) | 4.80±0.29 |
| Ash % | 0.34±0.03 | | |
| Moisture % | 86.32±0.14 | Ratio** | 2.0 |
| Ascorbic acid (mg/100g) | 5.52±0.35 | | |
| TSS° (Brix) | 11.0±0.82 | | |

**Ratio between β-carotene and β-cryptoxanthin contents. The values in the same column marked with different letters are significantly different (*P*<0.05) TSS=total solid soluble

**3.2. Chemical composition processed products (Jelly, Jam and Juice)**

Comparative studies of the chemical composition of Jelly, Jam and Juice prepared from loquat fruit were shown in table (2) results showed that, the total soluble solids were significantly higher in Jam(76.3%) as compared to Jelly and juice being (15.0 and 13.0) respectively. Jam should contain at least 45% to 68% of total soluble solids, however jelly should contain 65%. (Rakesh et *al*., 2011). It was found that loquat jelly contained more acidity 4.52% (as malic acid) as compared to jam and juice 4.22% and 3.87% respectively. These owing to the addition of acids to a stage at which a clear gel forms, these finding are in agreement with (Rakesh et *al.,* 2011). In addition, Egan *et al.,* 1985 reported that pH below 3.0 may often result in hard gels. Which the critical control points in jam manufacturing is the pH of the fruit pulp in balancing the sugar and pectin in order to facilitate gel formation (Ndabikunze et *al*., 2011).

Further, the data presented in table 2 revealed that loquat juice contained more amount of ascorbic acid (4.28 mg/100g) compared to Jelly and Jam.

Total carotenoid content were assessed on basis µg/g of B-carotene, highest amount of B-carotenoid was found in loquat Juice 9.75µg/g, followed by jelly (8.75 µg/g) and jam (6.15µg/g). While, β-carotene and β-cryptoxanthin content of loquat juice were in the same range as those found in fresh fruit.

**Table (2): Chemical composition of processed products.**

| Constituent % | Fruit products | | |
|---|---|---|---|
| | **Jelly:(M±SD)** | **Jam:(M±SD)** | **Juice:(M±SD)** |
| Carbohydrates % | 43.31±0.61 | 70.21±0.21 | 14.18±0.17 |
| Fat | 0.25±0.04 | 0.21±0.06 | N.D |
| Protein | 1.4±0.03 | 1.1±0.11 | 0.94±0.08 |
| Ash | 0.42±0.11 | 0.37±0.15 | 0.29±0.07 |
| Moisture | 18.7±0.12 | 11.2±0.14 | 88.78±0.12 |
| Ascorbic acid (mg/100g) | 3.21±0.11 | 1.29±0.05 | 4.28±0.21 |
| TSS ($^{o}$Brix) | 65.0±0.21 | 76.3±0.51 | 13.0±0.41 |
| pH (malic acid) | 4.52±0.25 | 4.22±0.21 | 3.87±0.31 |
| B-Carotene (µg/g) | 8.75±0.41 | 6.15±0.25 | 9.75±0.27 |
| B-cryptoxanthin (µg /g) | 3.65±0.35 | 2.78±0.14 | 4.74±0.31 |
| Ratio ** | 2.39 | 2.21 | 2.05 |

*values are the mean±SD
TSS=total solid soluble
**Ratio between B-carotene and B-cryptoxanthin contents. The values in the same column marked with different letters are significantly different (*P*<0.05)

Generally, Jelly and Jam contain much higher nutrients levels than the juices. Processing of jelly and jam results in water removal which may be due to the concentration of food nutrients (John et *al*., 2007).

**3.3 Minerals content of loquat fruit & it precede product (jelly, jam &juice):**

The mineral content of the fresh and processed loquat product are given in table (3). As shown in table 3, phosphorus, iron, potassium, sodium, magnesium and calcium are the predominant minerals in juice and fresh fruit samples. Phosphorus and iron showed a more considerable decrease than other minerals in jelly and jam with respect to the fresh loquat. Boiling fruit during preparation jelly and jam increase the losses of their minerals because the higher temperature of water during boiling Could cause an increase in solubility of element more than juice and fresh fruit (Hulya et *al*., 2011)

**Table(3): Minerals content of the loquat fruit and its processed products**

| Parameters (mg/100g) | Fruit products (mg/100g) | | | |
|---|---|---|---|---|
| | **Fresh loquat** | **Jelly** | **Jam** | **Juice** |
| Phosphorus | 27 | 24 | 23 | 29 |
| Iron | 4.3 | 3.2 | 3.4 | 5.2 |
| Potassium | 266 | 239 | 245 | 278 |
| Sodium | 35 | 32 | 33 | 39 |
| Magnesium | 13 | 11 | 11 | 18 |
| Calcium | 16 | 13 | 12 | 19 |

**3.4. Color of processed products (Jelly, Jam and Juice):**

The hunter color parametes L*, a* and b* have been widely used to describe the color properties of fresh loquat and its products were evaluated in table 4. The decrease of a* value reflects the redness of jam than jelly and juice, while, the decrease of yellowness B* in jam was found significant which indicated that boiling process demonstrated effectiveness on saving the yellowness.

Which a* and b* were positively correlated with the total content of colored carotenoids.

Also, the decrease of L* value reflects the darkening of loquat jam by carotenoid accumulation (Ruiz *et al.,* 2005).

**Table (4): Color of fresh loquat and processed products**

| Fruit products | L* | a* | b* | a/b |
|---|---|---|---|---|
| Fresh | 34.25±0.14 | 17.01±0.17 | 19.31±0.13 | 0.88 |
| Jelly | 35.22±0.71 | 15.51±0.25 | 19.66±0.31 | 0.78 |
| Jam | 22.01±0.51 | 13.71±0.35 | 13.82±0.41 | 0.99 |
| Juice | 31.52±0.12 | 15.03±0.15 | 17.51±0.11 | 0.85 |

*Values are the means±SD.

**3.5. Sensory evaluation of processed products (Jelly, Jam and Juice):**

Sensory evaluation of loquat jelly, jam and juice was presented in table 5. The data revealed that jelly, jam and juice were rated acceptable by the panelists, however, loquat jam was adjudged best for color and flavour while taste and consistency of loquat juice recorded highest total scores.

**Table (5): Sensory evaluation of loquat processed products**

| Parameters | Jelly | Jam | Juice | L.S.D |
|---|---|---|---|---|
| Appearance | $9.0^{b}$ ±0.12 | $9.1^{a}$ ± 0.12 | $9.5^{a}$ ±0.21 | 0.41 |
| Colour | $9.0^{ab}$±0.29 | $9.2^{ab}$ ± 0.41 | $9.2^{a}$±0.31 | 0.22 |
| Flavor | $8.3^{a}$±0.18 | $8.4^{a}$± 0.19 | $7.4^{b}$ ±0.24 | 0.81 |
| Taste | $8.2^{b}$±0.44 | $9.1^{ab}$± 0.35 | $9.3^{a}$ ±0.37 | 0.85 |
| Consistency | $8.1^{c}$±0.17 | $9.2^{b}$ ± 0.38 | $9.5^{a}$±0.45 | 0.30 |

L.S.D=Less significant difference at 0.05 alpha level.

Means in the same raw with different letters are significantly different ($P \leq 0.05$)

**Conclusion:**

In conclusion, we demonstrated that loquat fruit is highly nutritious value which can play a great role in human health.

The analyzed nutrient content showed that loquat jelly and juice are rich source of ascorbic acid and B-carotene beside other nutrient. Hence, considering nutritive value as well organoleptic qualities of the prepared products as jelly, jam and juice there can be commercialized and popularized for human consumption.

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