Physico-chemical Quality Parameters of Mango (
Mangifera indica L.) Fruits Grown in a 
Mediterranean Subtropical Climate (SE Spain)

C. R. Rodríguez Pleguezuelo\textsuperscript{1}, V. H. Durán Zuazo\textsuperscript{2*}, J. L. Muriel Fernández\textsuperscript{2}, and D. Franco Tarifa\textsuperscript{3}

ABSTRACT

Mango (Mangifera indica L.) production is on the rise in various subtropical zones throughout the world. The cultivation of this fruit tree is feasible along the coast of Granada, where some 1,500 ha are presently grown. In 2006, the EU exported 118 thousand tonnes of mangoes at a value of 131 million euros. This study was conducted to assess the physico-chemical quality characteristics of some mango fruit cultivars growing under a Mediterranean subtropical climate in Spain. A number of twenty-five fruits from eight Florida and one Australian cultivars were collected from different trees at the preclimacteric hard-green stage, and weighed. Osteen fruits bore the greatest weight (697 ± 95 g) with their pulp:seed ratio ratios (20:2) significantly higher than those in the other cultivars tested. The lowest pulp:seed ratios were recorded for the cultivars Kensington (6.3) and Sensation (7.6). The fruits with the highest percentages of flesh belonged to cvs. Glen, Palmer, and Osteen, each averaging 85%. The seed-weight of the fruits of cv. Osteen proved the lowest (4.2%) among all the cultivars, confirming the most desirable relationship with the pulp. The highest acidity (0.22%) went to Valencia Pride while Lipsens contained the highest Total Soluble Solids (TSS). The TSS:TA ratios proved the highest for cvs. Kent (382) and Lipsens (333), which might be indicative of the effect on their flavour. All the mango cultivars tested in this subtropical marginal area, especially cvs. Osteen and Tommy Atkins, met the standard parameters for high-quality fruits, and can be recommended for their performance and sustainable yield in such type of environments.

Keywords: Florida cultivars, Mango, Marginal area, Titratable acidity, Total soluble solids.

INTRODUCTION

Mango (Mangifera indica L. Family Anacardiaceae), is one of the most profitable crops in tropical and subtropical regions in the world. Originating in the Himalayan foothills of the Indian-Myanmar region, it has been cultivated for more than 4,000 years and is renowned for its excellent flavour, attractive fragrance, and high nutritional value. Mango can play an important role in balancing human diet by providing about 64-86 calories of energy per 100 g (Rathore et al., 2007) and, when consumed regularly, can be a valuable dietary source of many phytochemical compounds (Haard and Chism, 1996). In

\textsuperscript{1} Research and Training Institute for Agriculture and Fisheries, “Camino de Purchil”. Apdo. 2027, 18080 Granada, Spain.
\textsuperscript{2} Research and Training Institute for Agriculture and Fisheries, “Las Torres-Tomejil”, Carretera Sevilla-Cazalla km 12.2, 41200, Alcalá del Río, Sevilla, Spain.
\textsuperscript{*} Corresponding author, e-mail: victorh.duran@juntadeandalucia.es
\textsuperscript{3} Finca Experimental “El Zahorí” Ayuntamiento de Almuñécar, Plaza de la Constitución 1, 18690 Almuñécar (Granada), Spain.
addition, among many other components, the ascorbic acid content makes the fruit an excellent source of vitamin C, its content varying from 32 to 200 mg per 100 g of edible pulp (Akinyele and Keshinro, 1980).

Over the last decade (1991-2001), mango growing area has increased by 42.5% (Malik and Singh, 2006), due to the interest increasing in the fruit’s fresh as well as processed consumption (Materano et al., 2004). The world production of the fruit is estimated to be over 23.4×10^6 tonnes per year and is expected to increase (Materano et al., 2004). Spain is the main European producer of subtropical fruits, with approximately 1,400 ha dedicated to mango (Galán and Farre, 2005). In particular, the coast of Granada (SE, Spain) has a large potential for the cultivation of tropical and subtropical fruit trees, with a favourable year-round climate and infrequent frosts. In this region, hillsides have traditionally been terraced and today intensive irrigated agriculture has been established along with diverse tropical and subtropical crops, including avocado (Persea americana Mill.), mango (Mangifera indica L.), loquat (Eriobotrya japonica L.), custard apple (Annona cherimola Mill.), and litchi (Litchi chinensis Sonn.) among others (Durán et al., 2003; 2006a). Mango orchards are established on the hillside terraces 2-3 m wide with single rows of mango trees spaced 3-4 m apart. A large number of Florida mango cultivars are grown in the study zone but the physico-chemical characteristics of most of them have not yet been studied for this crop and in this type of marginal area. Each mango cultivar is distinct from others in colour and flavour, and therefore varies in its suitability for certain uses. Mango was introduced to Florida in the 19th century, from the West Indies and from India. In the 20th century, there were further introductions from southern Asia (primarily from India and as well from other countries). As a result, a grade of mangoes called “Florida” was developed (Knight and Schnell, 1994; Olano et al., 2005), being hybrids between Indian (monoembryonic) and South-east Asian types (polyembryonic). As it is widely consumed but delicate fruit, care needs to be taken to conserve its quality from harvesting until consumption.

The aim of the present study is to assess the physico-chemical characteristics of mango fruits especially those of Florida cultivars growing in a marginal area under a Mediterranean subtropical climate in the coast of south-eastern Spain. This could be very important as regards consumers, marking new expectations of emerging markets.

**MATERIALS AND METHODS**

The study was carried out for two growing seasons at the experimental station “El Zahorí” (Almuñécar, SE Spain; 36º 48’00”N, 3º 38’0”W) (Figure 1). The local
temperatures vary from subtropical to semi-
hot within the Mediterranean subtropical 
climatic category (Elias and Ruiz, 1977). 
The average annual rainfall in the study zone 
is 449.0 mm; however, the Mediterranean 
climate shows a complex pattern of spatial 
and seasonal variability, which is 
exacerbated by the unpredictability of 
rainfall from year to year, within the year, 
and spatially during a single rainfall event 
(Ramos and Martínez, 2006). The soils, 
formed from weathered slates, vary in depth, 
and some being rocky, providing in general 
very good drainage. They are classified as 
Typical Xerorthent (Soil Survey Staff, 
1999), with 684 g kg\(^{-1}\) of sand, 235 g kg\(^{-1}\) of 
silt and 81 g kg\(^{-1}\) of clay, containing 9.4 g kg\(^{-1}\) of 
organic matter, and 0.7 g kg\(^{-1}\) of N, with 
14.6 mg kg\(^{-1}\) P and 178.7 mg kg\(^{-1}\) of 
assemblable K (MAPA, 1986). The 
experimental mango orchards were drip 
irrigated and managed according to 
conventional practices in the area, using the 
same fertilization (240 g N, 71 g P\(_2\)O\(_5\), and 
212 g K\(_2\)O) practices and routine cultivation 
techniques for diseases and insect control. 
Eight Florida mango cultivars were 
considered [Osteen (OS), Tommy Atkins 
(TA), Sensation (SE), Glenn (GL), Palmer 
(PA), Lippens (LI), Irwin (IR) and Valencia 
Pride (VP)] together with one Australian 
cultivar namely: Kensington (KE). The 
fruits were harvested during two seasons 
(2006-2007) from August to October at the 
appropriate harvest time of each cultivar. 

At the preclimacteric hard-green stage, 25 
fruits per cultivar were collected from 
different trees by a trained person. Within 24 
h of being harvested, the fruits were taken to 
the laboratory where undamaged fruits were 
stored at 12°C and 85-90% of relative 
humidity, conditions recommended by 
Salunkhe (1984), until they reached the 
proper maturity level for processing (about 
7-10 days). Also, the daily weight loss of 
fruits until maturity was recorded. The fruits 
were peeled with the pulp, seed, and peel 
separated. Each fraction was weighed. The 
total soluble solids (TSS) was determined by 
use of refractometer (Eclipse, Bellinghan 
and Stanley, Ltd.) (AOAC, 1999); pulp 
samples were homogenized in a blender. 
From a few drops of thoroughly mixed 
sample, a direct refractometer reading was 
taken as described by AOAC (1984), the 
results being reported as Brix degrees at 
20°C. Titratable acidity was measured in the 
pulp through titration against NaOH, using 
phenolphthalein as an indicator. The data 
were expressed in % citric acid according to 
standard methods (AOAC, 1984):

\[
\text{% citric acid} = \frac{V \times N \times W_{\text{meq}}}{Y} \times 100
\]

Where: 
\(V\) = ml of NaOH solution used for 
titrination, 
\(N\) = Normality of NaOH solution, 
\(W\) = Milliequivalent of citric acid of 0.064, 
and \(Y\) = sample weight (g)

Fruit samples (15 g) from each cultivar 
were homogenized for pH measurements 
through a digital pH meter (CRISON 
miropH2002). For texture measurements 
(kg m\(^{-2}\)), the fruits were peeled at two points 
in the equatorial area and the texture 
measured through a fruit penetrometer (fruit 
firmness tester) (PCE-PTR 200) with 
crossheads of 8 mm. Also shape, skin 
colour, pulp colour, skin-pulp adherence, 
and presence of fiber were recorded. At the 
ripe stage, an analysis for some fruit 
organoleptic characteristics was made (De 
Laroussilhe, 1980; IBPRG, 1989). Analysis 
of variance (ANOVA) using statistical 
analysis package (Statgraphics v. 5.1.) was 
performed to ascertain the differences in 
fruit parameters among the different mango 
cultivars. Differences among individual 
means were tested using the Least 
Significant Difference test (LSD) at \(P < 0.05\) 
level.

**RESULTS AND DISCUSSION**

Figure 2 shows the average fresh fruit 
weight for each of the cultivars studied. The 
fruits from cv. Osteen (OS) carried the 
highest average weight (697±95 g), the 
difference with respect to the other cultivars 
being statistically significant (\(P< 0.05\)). By 
contrast, the Australian cv. Kensington (KE) 
had the lowest significant average weight


Figure 2. Average fresh weight for the cultivars studied at the maturity stage. TA: Tommy Atkins; LI: Lippens; SE: Sensation; OS: Osteen; IR: Irwin; GL: Gleen; KE: Kensington; VP: Valencia Pride, PA: Palmer. Vertical bars represent standard deviation. Different letters on columns are indicative of statistical difference (LSD, P< 0.05).

(171±28 g) while the rest of the cultivars did not statistically differ from each other. Thus, a medium-sized weight group was established for cvs. TA, PA, GL, VP, and IR, averaging 422 g, while a third group was comprised of cvs. SE and LI, averaging 332 g; and a fourth one constituted of cv. KE, weighing 171 g (Figure 2).

Similar weights for cv. Osteen fruits were found in the control treatment in the study area with a salinity experiment through Durán et al. (2004) (691 and 580 g for cv. Osteen fruits grafted on rootstocks Gomera-1 and Gomera-3, respectively) in south-eastern Spain. Regarding the remaining cultivars, comparable results were reported by Fernández et al. (2001) in Argentina for cv. Tommy Atkins (420.8 g), and by Soto et al. (2004) in Venezuela for cv. Irwin (345.8 g). By contrast, the average weight of cv. Valencia Pride found by the same author (562.3 g) was lower than that found in the present study. The cv. Kensington Pride (or Bowen) is the predominant variety in the Australian production (more than 95%) (Jacobi et al., 1998), but it is not widely marketed to Europe. In relation to cv. Sensation, findings similar to those in the present experiment have been reported by Yeshitela et al. (2004), in South Africa with an average fruit weight of 321 g.

The fruit is sold in the European market in quality classes based primarily on fruit size and (in some cultivars) colour, both traits being the main commercial characteristics of mango fruit of Florida cultivars that make them the most marketable fruits worldwide. Since weight is not a determining factor for quality in commercial terms the medium-sized fruits are more frequently appreciated by consumers. Internal quality components are not considered despite that a large or small fruit size can also be promoted in ways which do not necessarily guarantee high flesh quality. Pre-harvest growing conditions (i.e., cultivation practices, plant material, and climate) exert a major impact on fruit development and quality. The effects of different growing conditions on fruit size and yield for two Florida cultivars (cvs. Osteen and Keitt) in the study area have been discussed by Durán et al. (2006b), showing the potential environmental conditions for theirs cultivation.

Figure 3 shows the pulp:seed ratio for all the cultivars, showing a similar trend found for weight. The highest pulp:seed ratio was found for cv. Osteen (20.2), while the lowest ratios for cvs. Kensington (6.3) and Sensation (7.6). In addition, the cvs. Tommy Atkins and Irwin recorded acceptable ratios of 13.1 and 15.9, respectively. According to Avilan et al. (1998), the ideal mango fruit.
benefits from a high pulp:seed ratio, good firmness, appropriate consistency, fibre absence, and an adequate sugar:acidity ratio. In this sense, the highest pulp:seed ratio was found for cv. Osteen, making it one of the most valuable commercial cultivars on the Granada coast, as pointed out by other authors (Calatrava et al., 1993; Durán et al., 2003).

Table 1 presents the fruit yield, fruit characteristics, and the percentage weight of fruit peel, seed, and flesh of cultivars studied. Fruit yield was highly variable among the cultivars studied, the highest being recorded for cvs. Tommy Atkins, Osteen, and Valencia Pride. The fruits with the highest percentage of flesh were cvs. Glen, Palmer, and Osteen, with an average of 85%, whilst the lowest values were recorded for cvs. Kensington and Sensation, with 74 and 77%, respectively. For fruit skin, the lowest and highest values were

**Table 1. Percentage weight of skin, seed and flesh for the mango cultivars studied.**

<table>
<thead>
<tr>
<th>Mango cultivar</th>
<th>Fruit yield (kg tree⁻¹)</th>
<th>Skin weight (%)</th>
<th>Seed weight (%)</th>
<th>Flesh weight (%)</th>
<th>Fruit length (mm)</th>
<th>Equatorial diameter (mm)</th>
<th>Weight loss* (g day⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA</td>
<td>20.7 ± 8.1</td>
<td>11.2 ± 3.4</td>
<td>6.9 ± 2.2</td>
<td>81.9 ± 5.4</td>
<td>114.1 ± 6.6</td>
<td>92.4 ± 6.5</td>
<td>2.5 ± 0.4</td>
</tr>
<tr>
<td>LI</td>
<td>13.5 ± 6.8</td>
<td>9.70 ± 1.1</td>
<td>7.7 ± 0.8</td>
<td>82.6 ± 1.5</td>
<td>91.4 ± 6.1</td>
<td>81.4 ± 5.3</td>
<td>2.1 ± 0.5</td>
</tr>
<tr>
<td>SE</td>
<td>17.8 ± 9.7</td>
<td>12.0 ± 0.6</td>
<td>10.4 ± 1.5</td>
<td>77.6 ± 1.9</td>
<td>87.4 ± 5.2</td>
<td>72.5 ± 4.6</td>
<td>0.9 ± 0.4</td>
</tr>
<tr>
<td>OS</td>
<td>19.0 ± 5.7</td>
<td>10.3 ± 0.8</td>
<td>4.2 ± 0.2</td>
<td>85.5 ± 0.6</td>
<td>126.8 ± 7.0</td>
<td>90.7 ± 5.4</td>
<td>2.7 ± 0.5</td>
</tr>
<tr>
<td>IR</td>
<td>14.5 ± 7.5</td>
<td>10.8 ± 3.2</td>
<td>5.7 ± 1.9</td>
<td>83.5 ± 1.5</td>
<td>106.3 ± 5.7</td>
<td>78.4 ± 6.8</td>
<td>2.2 ± 0.3</td>
</tr>
<tr>
<td>GL</td>
<td>11.2 ± 8.3</td>
<td>6.30 ± 0.9</td>
<td>7.8 ± 0.6</td>
<td>85.9 ± 1.5</td>
<td>104.1 ± 9.1</td>
<td>75.4 ± 6.5</td>
<td>1.9 ± 0.5</td>
</tr>
<tr>
<td>KE</td>
<td>12.4 ± 8.7</td>
<td>13.4 ± 1.6</td>
<td>11.8 ± 0.6</td>
<td>74.6 ± 1.3</td>
<td>80.4 ± 8.3</td>
<td>75.1 ± 3.2</td>
<td>0.8 ± 0.4</td>
</tr>
<tr>
<td>VP</td>
<td>19.4 ± 7.4</td>
<td>6.90 ± 1.3</td>
<td>8.8 ± 0.3</td>
<td>84.1 ± 1.0</td>
<td>105.4 ± 4.6</td>
<td>80.2 ± 4.8</td>
<td>1.7 ± 0.5</td>
</tr>
<tr>
<td>PA</td>
<td>10.5 ± 6.8</td>
<td>7.30 ± 0.5</td>
<td>7.3 ± 1.7</td>
<td>85.4 ± 1.1</td>
<td>110.4 ± 7.8</td>
<td>91.8 ± 5.6</td>
<td>2.0 ± 0.4</td>
</tr>
</tbody>
</table>

* Fruit weight loss up to the maturity stage.

a Tommy Atkins; b Lippens; c Sensation; d Osteen; e Irwin; f Glen; g Kensington; h Valencia Pride, i Palmer.

Average ± Standard deviation.
found for cvs. Glen and Kensington, with 6.3 and 13.4%, respectively. The seed weight for fruits in cv. Osteen was the lowest (4.2%) in comparison with the other cultivars, confirming a better relationship with the pulp. On the other hand, the percentages of seed contribution to the total fruit weight for cv. Tommy Atkins and Irwin were acceptable (6.9 and 5.7%, respectively). Cultivars Kensington and Sensation showed the highest percentages of seed to total fruit weight (11.8 and 10.4%, respectively). The thinnest peel (6.3%) was reported for cv. Glen, this value being in contrast with that of Soto (2004), who reported it as 21%.

Table 2 shows the pH, textural firmness, Total Soluble Solids (TSS) and Titratable Acidity (TA) at maturity stage for the mango cultivars studied. In relation to the Total Soluble Solids (TSS), the cv. Lippens showed the highest value among all the cultivars, values ranging from 19.5% for cv. Osteen to 15.7% for cv. Glen. The results of the present study for TSS are in general higher than those reported by Fernández et al. (2001) in Argentina for cvs. Tommy Atkins, Osteen, Sensation, and Valencia Pride of 14, 14, 16, and 19%, respectively. This may be due to the longer period of sunlight exposure, since in the present study the trees were cultivated in south-facing orchard terraces under European Mediterranean conditions. In this context, a positive relationship between light-exposure time and TSS content has been pointed out in other crops by different authors (Owusu et al., 1978; Tombesi et al., 1993). As TSS and the TSS:TA ratio is considered a measure of fruit quality, it is generally recognized that quality fruits benefit from a higher sugar:acid ratio whereas fruits of lower quality suffer from a lower sugar:acid ratio. In this context, Palaniswamy et al. (1975), from India reported a TSS:TA ratio for high-quality mangos for cvs. Khirsapat, Gopalbhog and Langra of 162.5, 150.0, and 131.3, respectively. According to the present findings the highest TSS:TA ratios were recorded for cvs. Kent (382) and Lippens (333). However, the cultivars which had an acceptable equilibrium between TSS and TA were cvs. Osteen, Tommy Atkins, Palmer, and Glen with 144, 148, 142, and 121.3, respectively. Moreover, the TSS:TA ratios in these cultivars are similar to those reported by Palaniswamy et al. (1975).

The textural firmness is associated with the stage of maturity. Usually in the initial stages of fruit development, firmness remains almost constant whereas after firmness decreases as the fruit ripens, respectively. This may be due to the longer period of sunlight exposure, since in the present study the trees were cultivated in south-facing orchard terraces under European Mediterranean conditions. In this context, a positive relationship between light-exposure time and TSS content has been pointed out in other crops by different authors (Owusu et al., 1978; Tombesi et al., 1993). As TSS and the TSS:TA ratio is considered a measure of fruit quality, it is generally recognized that quality fruits benefit from a higher sugar:acid ratio whereas fruits of lower quality suffer from a lower sugar:acid ratio. In this context, Palaniswamy et al. (1975), from India reported a TSS:TA ratio for high-quality mangos for cvs. Khirsapat, Gopalbhog and Langra of 162.5, 150.0, and 131.3, respectively. According to the present findings the highest TSS:TA ratios were recorded for cvs. Kent (382) and Lippens (333). However, the cultivars which had an acceptable equilibrium between TSS and TA were cvs. Osteen, Tommy Atkins, Palmer, and Glen with 144, 148, 142, and 121.3, respectively. Moreover, the TSS:TA ratios in these cultivars are similar to those reported by Palaniswamy et al. (1975).

Table 2. Texture, pH, Total Soluble Solids (TSS) and Titratable Acidity (TA) at maturity stage for the mango cultivars studied.

<table>
<thead>
<tr>
<th>Mango cultivar</th>
<th>pH</th>
<th>Texture (kg m⁻²)</th>
<th>TSS(°Brix)</th>
<th>TA(%)</th>
<th>TSS:TA ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>LI</td>
<td>5.7 ± 0.2 b</td>
<td>2.7 ± 0.6 b</td>
<td>20.0 ± 1.9 b</td>
<td>0.06 ± 0.02 ab</td>
<td>333.3</td>
</tr>
<tr>
<td>SE</td>
<td>5.1 ± 0.3 ab</td>
<td>2.1 ± 0.2 ab</td>
<td>19.2 ± 0.8 ab</td>
<td>0.08 ± 0.01 ab</td>
<td>256.0</td>
</tr>
<tr>
<td>OS</td>
<td>5.4 ± 0.1 ab</td>
<td>1.7 ± 0.5 a</td>
<td>19.5 ± 0.6 ab</td>
<td>0.14 ± 0.03 c</td>
<td>144.4</td>
</tr>
<tr>
<td>TA</td>
<td>4.9 ± 0.5 ab</td>
<td>1.7 ± 0.3 a</td>
<td>18.4 ± 0.8 ab</td>
<td>0.12 ± 0.01 c</td>
<td>148.4</td>
</tr>
<tr>
<td>KE</td>
<td>4.3 ± 0.4 a</td>
<td>2.0 ± 0.1 ab</td>
<td>17.2 ± 6.7 ab</td>
<td>0.05 ± 0.03 a</td>
<td>382.2</td>
</tr>
<tr>
<td>PA</td>
<td>4.2 ± 0.2 a</td>
<td>1.7 ± 0.6 a</td>
<td>16.5 ± 0.7 ab</td>
<td>0.12 ± 0.01 bc</td>
<td>142.2</td>
</tr>
<tr>
<td>VP</td>
<td>4.8 ± 0.4 ab</td>
<td>1.8 ± 0.3 a</td>
<td>16.0 ± 1.1 a</td>
<td>0.22 ± 0.08 d</td>
<td>74.4</td>
</tr>
<tr>
<td>IR</td>
<td>5.0 ± 0.5 ab</td>
<td>1.6 ± 0.5 a</td>
<td>15.9 ± 2.5 a</td>
<td>0.18 ± 0.01 cd</td>
<td>89.7</td>
</tr>
<tr>
<td>GL</td>
<td>5.4 ± 0.3 ab</td>
<td>1.5 ± 0.6 a</td>
<td>15.7 ± 0.7 a</td>
<td>0.13 ± 0.04 c</td>
<td>121.3</td>
</tr>
</tbody>
</table>

Lippens; a Sensation; b Osteen; c Tommy Atkins; d Kensington; e Palmer; f Valencia Pride; g Irwin; h Glen. Average ± Standard deviation. Different letters within the same column represent the statistical difference (LSD, P< 0.05).
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apparently due to change in structure of the pectin polymers in the cell wall during the ripening process (Kalra et al., 1995). The maximum textural firmness was observed as 2.7 kg m$^{-2}$ when the TSS content was 20º Brix with cv. Lippens. Texture is one of the important quality parameters which plays a significant role in fruit selection by the consumer.

Table 3 shows some other important characteristics for the cultivars studied: fruit shape, skin colour, pulp colour, skin-pulp adherence, and fibre availability. With the exception of cvs. Kensington and Palmer, most of the cultivars dealt with in the present study were low in fibre, in agreement with Calatrava et al. (1996), the European consumers preferring fruits with this feature.

A great part of the production is exported mainly to the Netherlands, France, Germany, the United Kingdom, and Belgium. Thus, the characterization of the Spanish fresh mango fruit grown in the subtropical region of the Granada coast is crucial, in order to compete in the EU market. Moreover, the fruit yields in the study zone can be compared with those in the fully tropical areas, due to the high density plantations within orchard terraces (600 tree ha$^{-1}$, with an average commercial fruit yield of 15 kg tree$^{-1}$) (Table 1). In addition, Spanish mango cultivation could have benefit from market trends: on the one hand, the organic-production system is one with the highest potential along with the greatest demand by EU countries, providing opportunities for small-size farming. At present, the organic mango orchards in Granada are still nonexistent. Secondly, it is vital to establish market diversification— that is, to create new small- and medium-size industries dedicated to making mango added-value products. Since subtropical fruit farming is one of the main economic activities on the Granada coast, these two new possible trade opportunities for Spanish mango fruits could help the economy, which is steadily more unbalanced in favour of tourism, a trend causing a negative impact on the coastal environment.

It is concluded that a combination of a number of physico-chemical fruit parameters is employed to specify the quality of mango fruits. The results of the present experiment indicate that most of the Florida mango cultivars studied in this subtropical marginal area (the Granada coast of southern Spain) met the standard parameters for considering the fruit to be of high quality, especially cvs. Osteen and Tommy Atkins. Therefore, mango cultivation in south-eastern Spain offers promising possibilities for exporting high-quality fresh fruits, especially because of the vicinity to other EU countries.

### ACKNOWLEDGEMENTS

**Table 3.** Fruit organoleptic characteristics at maturity stage for each mango cultivars studied.

<table>
<thead>
<tr>
<th>Mango cultivars</th>
<th>Fruit shape</th>
<th>Visual and organoleptic characteristic</th>
<th>Adherence skin-pulp</th>
<th>Fibre presence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Skin colour</td>
<td>Pulp colour</td>
<td></td>
</tr>
<tr>
<td>L1*</td>
<td>Oval</td>
<td>Yellow-Pink</td>
<td>Yellow</td>
<td>Medium</td>
</tr>
<tr>
<td>SE**</td>
<td>Oval</td>
<td>Purple</td>
<td>Orange</td>
<td>Medium</td>
</tr>
<tr>
<td>OS*</td>
<td>Ovoid</td>
<td>Red-purple</td>
<td>Orange</td>
<td>Medium</td>
</tr>
<tr>
<td>TA**</td>
<td>Ovoid-oval</td>
<td>Red</td>
<td>Orange</td>
<td>Medium</td>
</tr>
<tr>
<td>KE*</td>
<td>Ovoid-oblique</td>
<td>Green-yellowish</td>
<td>Yellow-range</td>
<td>Low</td>
</tr>
<tr>
<td>PA*</td>
<td>Oval</td>
<td>Yellow-orange</td>
<td>Orange</td>
<td>Medium</td>
</tr>
<tr>
<td>VP**</td>
<td>Ovoid-kidney</td>
<td>Yellow-orange</td>
<td>Orange</td>
<td>Medium</td>
</tr>
<tr>
<td>IR*</td>
<td>Ovoid</td>
<td>Red-orange</td>
<td>Yellow</td>
<td>Medium</td>
</tr>
<tr>
<td>GL**</td>
<td>Ovoid</td>
<td>Red-purple</td>
<td>Yellow</td>
<td>Medium</td>
</tr>
</tbody>
</table>

* Lippens; ** Sensation; * Osteen; ** Tommy Atkins; * Kensington; * Palmer; * Valencia Pride; * Irwin, * Gleen.
The research work that leads to this publication “Environmental Impact of Farming Subtropical Species on Steeply Sloping Lands. Integrated measures for sustainable agriculture” (RTA05-00008-00-00), granted by INIA, Spain and co-financed by FEDER funds (European Union).

REFERENCES

Physico-chemical Quality Parameters of Mango Fruits


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مرجع 1: پلگوئزئوالو، رودریگز، و تیمکس (2023) فاکتورهای مؤثر بر خواص محیطی بهاره در باغات انگلیس و کانادا. فصلنامه دانشگاهی مرکز مطالعات علمی و تحقیقاتی ایران، شماره 40 (2):

ملاحظات
1. هر سیستم گیاهی با ویژگی‌های خاصی خود در معرض طبیعت می‌باشد.
2. تاثیرات فیزیولوژیکی و فنیکولوژیکی در بحث و گفتگو با طراحی و بیان این جملات قابل استفاده برای تدوین مقالات علمی و تحقیقاتی می‌باشد.
3. همگرا در پیشنهادات و برنامه‌ریزی‌های علمی و تحقیقاتی می‌باشد.

دلیل
1. تاثیرات فیزیولوژیکی و فنیکولوژیکی در بحث و گفتگو با طراحی و بیان این جملات قابل استفاده برای تدوین مقالات علمی و تحقیقاتی می‌باشد.
2. همگرا در پیشنهادات و برنامه‌ریزی‌های علمی و تحقیقاتی می‌باشد.
3. تاثیرات فیزیولوژیکی و فنیکولوژیکی در بحث و گفتگو با طراحی و بیان این جملات قابل استفاده برای تدوین مقالات علمی و تحقیقاتی می‌باشد.
4. همگرا در پیشنهادات و برنامه‌ریزی‌های علمی و تحقیقاتی می‌باشد.

توضیحات
1. تاثیرات فیزیولوژیکی و فنیکولوژیکی در بحث و گفتگو با طراحی و بیان این جملات قابل استفاده برای تدوین مقالات علمی و تحقیقاتی می‌باشد.
2. همگرا در پیشنهادات و برنامه‌ریزی‌های علمی و تحقیقاتی می‌باشد.
3. تاثیرات فیزیولوژیکی و فنیکولوژیکی در بحث و گفتگو با طراحی و بیان این جملات قابل استفاده برای تدوین مقالات علمی و تحقیقاتی می‌باشد.
4. همگرا در پیشنهادات و برنامه‌ریزی‌های علمی و تحقیقاتی می‌باشد.