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Altın Çilek (Physalis peruviana L.), Pepino (Solanum muricatum Ait.) ve Passiflora (Passiflora edulis Sims) Tropikal Meyvelerinin Bazı Fizikokimyasal Özellikleri ve Antioksidan Aktiviteleri

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Özet

Bu çalışmada Mersin bölgesinde yetiştirilen altın çilek (Physalis peruviana L.), pepino (Solanum muricatum Ait.) ve passiflora (Passiflora edulis Sims.) tropikal meyve türlerinin meyve ağırlığı, meyve çapı, meyve uzunluğu, meyve en/boy oranı, toplam suda çözünebilir kuru madde (SÇKM), pH, titre edilebilir asitlilik, meyve rengi ve antioksidan içerikleri gibi bazı fiziko kimyasal özellikleri değerlendirilmiştir. Araştırma sonucunda, meyve ağırlığı bakımından altın çilek meyvesi 2.268 g, pepino 203.263 g ve passiflora meyvesi 44.210 g. olarak bulunmuştur. Meyve en/boy oranı altın çilekde 0,914; pepinoda 0.946 ve passiflorada 0.864 olmuştur. Suda çözünebilir toplam kuru madde bakımından altın çilek %14.133, pepino % 5.515 ve passiflora ise % 15.400 değerlerini vermişlerdir. Diğer taraftan pH seviyeleri altın çilek meyve suyunda 4.467, pepinoda 5.340 ve passiflorada ise 3.833 olarak ölçülmüştür. Aynı zamanda titre edilebilir asitlilik açısından sitrik asit en baskın asit olup, altın çilek meyve suyunda %1.827, pepinoda % 0.026 ve passiflorada %1.429 oranlarında belirlenmiştir. Elde edilen meyve renk ölçüm değerleri olan L (parlaklık, 100 = beyaz, 0 = siyah), a (+, kırmızı; -, yeşil) ve b (+, sarı; -, mavi) sırasıyla altın çilek meyveleri için 56.620, 5.450, 31.980; pepino meyveleri için 69.122, -2.294, 23.347 ve passiflora meyveleri için ise 50.594, 2.504, 23.498 olarak bulunmuştur. Bunlara ek olarak, toplam antioksidan aktivitesi en yüksek passiflora meyvelerinde olup, bunu pepino ve altın çilek meyveleri izlemiştir.

Anahtar Kelimeler: *Physalis peruviana L., Solanum muricatum Ait., Passiflora edulis Sims, fizikokimyasal özellikler, antioksidan aktiviteleri*

Some Physico-chemical Properties and Antioxidant Activities of Goldenberry (Physalis peruviana L.), Pepino (Solanum muricatum Ait.) and Passiflora (Passiflora edulis Sims) Tropical Fruits

Abstract

In this study, some physico-chemical properties in terms of fruit weight, fruit diameter, fruit length, fruit width/length, total soluble solids (TSS), pH, titratable acidity, fruit color and antioxidant content in different goldenberry (Physalis peruviana L.), pepino (Solanum muricatum Ait.) and passiflora (Passiflora edulis Sims) tropical fruits are assessed in Mersin region. At the end of the research, in terms of fruit weights are found as goldenberry fruit 2.268 g, pepino fruit 203.263 g and passiflora fruit 44.210 g. Fruit width/length ratios are measured as at goldenberry 0.914, pepino 0.946 and passiflora 0.864. In point of total soluble solids are determined as at goldenberry fruits 14.133 %, pepino fruits 5.515 % and passiflora fruits 15.400 % with ratio respectively. On the other hand, pH levels are measured as at goldenberry fruit juice 4.467, pepino fruit juice 5.340 and passiflora fruit juice 3.833. At the same time, in terms of titratable acidity all of fruits is determined as most dominant citric acid and at goldenberry fruit juices 1.827 %, pepino fruit juices 0.026 % and passiflora fruits juices 1.429 % are determined ratios. Obtained from fruit color measures L (brightness, 100 = white, 0 = black), a (+, red; -, green) and b (+, yellow; -, blue) results are determined for Goldenberry fruit, 56.620, 5.450, 31.980; for pepino fruits 69.122, -2.294, 23.347 and for passiflora fruits 50.594, 2.504, 23.498 respectively. In addition to, Passiflora fruits had the highest total antioxidant activity, followed by pepino and goldenberry.

Key Words: *Physalis peruviana L., Solanum muricatum Ait., Passiflora edulis Sims, physicochemical properties, antioxidant activities*

Introduction

Goldenberry, Pepino and Passiflora are a new crop for Turkey. In terms of fruit production, Mersin ranks first province in Turkey. Because of favourable climate in the Mersin province, some tropical fruit species (goldenberry, pepino, passiflora etc.) cultivation has gained importance.

Physalis peruviana L. or "cape gooseberry = goldenberry" is a member of the *Solanaceae* family. The fruit is a small round berry about the size of a marble with numerous small yellow seeds. It is bright yellow and sweet when ripe, making it ideal for snacks, pies or jams. It is popular in fruit salads, sometimes combined with avocado. Scientific studies of the cape

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gooseberry show its constituents, possibly polyphenols and/or carotenoids, demonstrate anti-inflammatory and antioxidant properties (Wu et al. 2006, Franko et al. 2007, Pardo et al. 2008). *Physalis peruviana* is a widely used medicinal herb for treating cancer, malaria, asthma, hepatitis, dermatitis and rheumatism (WU et al. 2005). The other plant, pepino (*Solanum muricatum*) is an exotic fruit that is produced from the pepino plant, which is a small bush that resembles a tomato vine and which grows to approximately three feet in height. Pepinos can be found in climates where the weather is moderate, frost-free, and where much sunshine is present and is native to South America. It tastes similar to a cucumber and a honeydew melon, because of this; other common names for the pepino include melon shrub, tree melon, mellow fruit, pear melon, and the sweet cucumber. Ripe fruits appear greenish-yellow to creamy color with purple strips on the skin. It has a very pleasant sweet taste similar to honey melon. High quantities of vitamins and some medicinal actions such as antitumor effects are the main characteristics of the fruit (Prono-Widayat et al., 2003). Another plant, *Passiflora edulis* Sims is a vine species of passion flower that is native to Paraguay, Brazil and northeastern Argentina. The passion fruit is round to oval, either yellow or dark purple at maturity, with a soft to firm, juicy interior filled with numerous seeds. The fruit can be grown to eat or for its juice, which is often added to other fruit juices to enhance the aroma. The fruit shown are mature for juicing and culinary use. For eating right out of the fruit, allow the fruit to wrinkle for a few days to raise the sugar levels and enhance the flavor (Anonymous 2010).

Some types of vegetables and fruits in general protect against some cancer types. Since fruits and vegetables happen to be good sources of antioxidants (which are substances that may protect cells from the damage caused by unstable molecules known as free radicals, this suggested that antioxidants might prevent some types of diseases (Stanner et al., 2004). Free radicals have been regarded as the fundamental cause of different kinds of diseases, including aging, coronary heart disease, inflammation, stroke, diabetes mellitus, rheumatism, liver disorders, renal failure and cancer (Bulkley 1983, Cheng et al. 2003).

Recently, some studies have been published about some physico-chemical properties and antioxidant activity of goldenberry, pepino and passiflora fruits. On the other hand, the bioactive content of fruits varies probably due to growing at different climate and soils. Therefore, attention has more recently been focused on assessing the distribution on biologically active compounds among different varieties which are grown in Mersin ecological conditions. In the present study, some physico-chemical properties and the antioxidant activity of goldenberry, pepino and passiflora fruits were examined with the different antioxidant assays including free radical scavenging activity, Fe^{+2} chelating activity (%) and H_2O_2 inhibition activity.

Materials and methods

Materials

Ripe goldenberry, pepino and passiflora fruits were obtained from local growers in Akcami village in Mersin city inTurkey during the mid-May 2010 season.

Methods

Physico-chemical analysis

Sampling: Ten fruits of each treatment were used for all analysis.

Determination of fruit mass: Fruit weight was measured by an electronic balance with an accuracy of 0.01 g. Each measurement was replicated 10 times.

Determination of size: From the samples, 10 fruits were selected at random for determining the physical characteristics. For each fruit, length and width values were measured using a digital calliper.

Acidity: Titratable acidity, expressed as % of malic acid, was determined in 10 ml of juice plus 50 ml of distilled water by titration to pH 8.1 with 0.1 N NaOH.

pH: The pH value was measured using a digital pH meter.

Total soluble solids: The total soluble solids (TSS), expressed as %, was determined in the juice of each sample using a portable refractometer at 21C.

Color: Fruit color was evaluated by measuring Hunter L (brightness, 100 = white, 0 = black), a (+, red; -, green) and b (+, yellow; -, blue) parameters by means of a reflectance colorimeter (CR 300, Chromometer, Minolta, Japan). A white tile (No: 21733001) was used to standardize the instrument.

Preparation of extracts for antioxidant activities: About 2.5 g fresh fruit samples were extracted by homogeny in mixer (Ultra turrax) with 50 ml solvent (50% water-methanol). The extracts were centrifuged at 4,000 x g for 3 min at 4°C after draining on coarse filter paper. And than the filtrate was drained by blue band filter paper (no: 391).

Free radical scavenging effect: The radical scavenging activity against the DPPH (diphenylpicrylhydrazyl) radical was evaluated according to the method of Serteser et al. (2008), with some minor modifications. The assay mixture contained 1.5 ml of 0.09 mg/ml DPPH (Sigma Chemical Co., St Louis, MO, USA) in methanol, 1 ml acetate buffer solution (100 mM, pH 5.5). The dilutions between 0.4 and 4 mg/ml were prepared with methanol. Then 3.9 ml DPPH solution prepared with $6x10^{-5}$ M methanol was added to each 0.1 ml dilution and shaken well. The mixture

was prepared and incubated for 60 min at room temperature in the dark. The absorbance of the remaining DPPH was determined at 517 nm against a blank. The scavenging activity was expressed as the IC_{50} value (mg/ml). All analyses were carried out duplicate.

Linear regression equations of absorbance against concentrations were determined by measuring the absorbances of seven different concentrations of DPPH ($6x10^{-5}$ M) stock solution: A (517 nm)=15,465 (C DPPH)-0:0187 (R^2=0,987)

The remaining DPPH concentrations against absorbance values of sample series of different concentrations were calculated and then the remaining DPPH percentage was calculated:

% Remaining DPPH=[DDPH] sample/[DPPH] control

Exponential regression equation was obtained between the rate of the remaining DPPH percentage and the DDPH amount of sample in vitro, and the sample concentrations of plants that decrease the initial DPPH concentrations by 50% (efficient concentration [EC_{50}]). The antiradical activity (AE) was calculated by dividing EC_{50} values into 1.

Fe^{2+} chelating activity: The modified methods of Lim & Murtijaya (2007) were used for determination of the Fe^{2+} chelating activities of samples. One milliliter of extracts with different concentrations between 6 and 45 mg/ml and 3.7 ml deionizer water were mixed. 0.1 ml of 2 mol $FeCl_2$ solution was added and shaken and kept at dark and room temperature for 70 min. Then, 0.2 ml of 5 mM ferrozin was added and shaken again, and the absorbance of the obtained Fe^{2+}-ferrozin complex after 10 min was measured at 562 nm. One millilitre of water was used instead of sample for the control. The equation is as follows (Yen & Wu, 1999):

Chelating activity (%)=[1-(absorbance of sample/absorbance of control)]x100

H_2O_2 inhibition effect: The H_2O_2 inhibition effect of spice and plant extracts was determined by spectrophotometer (Ruch et al., 1989). One millilitre (2.6 and 10 mg/ ml) of sample, 3.4 ml of 0.1 M phosphate buffer (pH 7.4) and 0.6 ml of 43 mM H_2O_2 were mixed and after 60 min the absorbance of mixture was measured at 230 nm. Control solutions without H_2O_2 were prepared for each sample concentration. To determine the H_2O_2 concentration that was not involved in the reaction, a linear repression equation was used. Phosphate buffer (3.4 ml) was added to 0.6 ml 10.15, 25.43 at 230 nm. Linear equation formulas were obtained by the graphic of Standard curve of absorbance vs. different concentrations of (+)- Catechin

A (230)=0.0125 x C (H_2O_2, mM)+0.0873 (R^2=0.9783)

(+)-Catechin was used as the reference antioxidant. The equation used is as follows:

H_2O_2 inhibition capacity (%)=[1-(H_2O_2 conc. of sample/H_2O_2 conc. of control)] x100

Statistical analyses

Statistical analysis was done using the JAMP. Differences between means were analysed by ANOVA test ($p<0.05$) (Püskülcü & İkiz, 1989). This research was performed by three duplicates with a replicate.

Results and Discussion

In this study, some physico-chemical properties in terms of fruit weight, fruit diameter, fruit length, fruit width/length, total soluble solids (TSS), pH, titratable acidity, fruit color and antioxidant content in different goldenberry, pepino and passiflora tropical fruit are assessed in Mersin region.

When values relative to fruit largeness was examined, it was found that goldenberry fruit was 2.268 g, pepino fruit was 203.263 g and passiflora fruit was 44.210g (Table 1). Ruiz and Nuez (1997) reported that the variation of fruit size, shape, color and flavour among pepino clones is striking. However, in most of the commercial cultivars the fruits weight between 100 to 300 g; are round, ovate or elongate in shape, yellow-skinned with purple stripes, juicy, aromatic and with a flavour resembling muskmelon. Prohens et al. (2005) found that the highest pepino fruit weight was in EC-37 (143.8 g), while the wild accessions EC-26, EC-40, and their hybrid showed the lowest values (8.8-10.0 g). In our study, it was found that the weight of pepino fruit higher than the mentioned values. Kola (2010) determined that pepino fruits (cv. Miski) were egg-shaped, watery, of 210-370 g/fruit weight.

Fruit widht / length rates were 0.914 in the goldenberry fruits, 0.946 in the pepino fruits, and 0.864 in the passiflora fruits (Table 1). Prohens et al. (2005) found that the highest length/width ratio was in EC-37 (1.080), while the wild accessions EC-26, EC-40, and their hybrid showed the lowest values (1.140-1.235). The interspecific hybrid (EC-37xEC-26) showed the highest ratio (1.542). In the pepino species tested by Prohens et al. (2005), it was attracted attention that fruits were longer. It may be said that fruits were more flattened when the value obtained from pepino (0.946) was considered in our study. Kola (2010) determined that pepino fruits (cv. Miski) were 6-12.5 cm in diameter, 7-14.5 cm long, hollow in the middle with several small seeds attached, and with 82-89 % edible part.

It was obtained that the ratios of dry matter contents were 14.133 % in the goldenberry fruits, 5.515 % in the pepino fruits and 15.400 % in the passiflora fruits (Table 1). Prohens et al. (2005) found that significant differences among accessions were found for soluble solids. *Solanum muricatum* (EC-37), *S. caripense* (EC-40) and their hybrids showed the highest levels, which ranged from 2.0 to 2.6 g 100 g^{-1}. Although *S. tabanoense* (EC-26) showed the lowest values (<0.9 g

100 g^{-1}), the interspecific hybrids including this accession as a parent had levels greater than 1.8 g 100 g^{-1}. Dry matter content of pepino fruit was found higher than the values were obtained by Prohens et al. (2005). Brava & Arias (1983) reported that ripe fruits of pepino contain 9.5% soluble solid, 4.6% carbohydrates, 0.06% acids and 34.25 mg (%) vitamin C. Dry matter content was found more close to values obtained by Brava and Arias (1983), but it was still higher. Kola (2010) determined that pepino fruits (cv. Miski) had brix (total soluble solids, TSS) from 4.91 to 5.40. Ramadan and Moersel (2007) found that Ripe goldenberry fruits were obtained from local growers in Zagazig (Sharkiah, Egypt) during the mid- May 2004 season. They found that TSS content was 10.5 °Brix pH levels were obtained as 4.467 in the goldenberry fruit juices, 5.340 in the pepino fruit juices, and 3.833 in the passiflora fruit juices (Table 1). Prohens et al. (2005) were studied in EC-37 (*Solanum muricatum*), EC-40 (S. *caripense*), EC-26 (S. *tabanoense*) and interspecific hybrids. They found that the highest pH value was in EC-37 (5.36), while the wild accessions EC-26, EC-40, and their hybrid showed the lowest values (3.70-3.87). The interspecific hybrids with EC-37 had pH values intermediate between the parents. pH levels of pepino fruits involved in our research were same as the values obtained by Prohens and et al.(2005) in *S. muricatum*. Kola (2010) determined that pepino fruits (cv. Miski) pH values from 4.72 to 5.22. Ramadan and Moersel (2007) found that Ripe goldenberry fruits were obtained from local growers in Zagazig (Sharkiah, Egypt) during the mid- May 2004 season. They found that pH value of the pulp was 3.86.

Table 1. Some physico-chemical properties of Goldenberry, Pepino and Passiflora fruit

	Fruit Species		
	Goldenberry	**Pepino**	**Passiflora**
Fruit weight (g)	2,268	203,263	44,210
Fruit width (mm)	15,796	71,942	45,765
Fruit length (mm)	16,780	76,474	53,035
Fruit width/length	0,914	0,946	0,864
TSS (%)	14,133	5,515	15,400
pH	4,467	5,340	3,833
Titratable acidity(%)	1,827	0,026	1,429
	Fruit Colour		
L	56,620	69,122	50,594
a	5,450	-2,294	2,405
b	31,980	23,347	23,498

Table 2. DPPH radical scavenging effects, Fe^{+2} chelating activity (%) and H_2O_2 inhibition activity (%) of fruit extracts

	Fruit Species			
	Goldenberry	**Pepino**	**Passiflora**	**LSD value**
EC_{50}	0,950	1,363	1,273	
AE	0,513 c	0,734 b	0,786 a	0,050
Fe Chelating Activity	38,677 c	47,413 b	48,993 a	1.570
H_2O_2 Inhibition	42,837 c	64,817 b	67,290 a	1.205

[a]*Efficiency coefficient (EC_{50}) (mg sample/ mg DPPH): sample amount needed to decrease the DPPH concentration at the beginning by 50 %,* [b]*Antiradical activity (AE): 1 / EC_{50}.*

***** *Values in all the lines not connected by same letter are significantly different (P<0,05)*

In the evaluations pertaining to citric acid which was dominant all three fruit types, the ratios obtained as 1.827 % in the goldenberry fruit juices, 0.026 in the pepino fruit juices, and 1.429 % in the passiflora fruit juices. Kola (2010) determined that pepino fruits (cv. Miski) had the titratable acidity (%) ranging from 0.090 to 0.124.

L (brightness, 100 = white, 0 = black), a (+, red; -, green) and b (+, yellow; -, blue) values obtained from fruit color measurements were determined as 56.620, 5.450, 31.980 for goldenberry fruits; 69.122, -2.294, 23.347 for pepino fruits; and 50.594, 2.504 and 23.498 for passiflora fruits, respectively.

There is convincing epidemiological evidence that the consumption of fruits and vegetables is beneficial to health and contributes to the prevention of degenerative processes, particularly lowering incidence and mortality rate of cancer and cardio- and cerebrovascular diseases (Hertog et al. 1993). The protection that fruits and vegetables provide against these diseases

has been attributed to the various antioxidant phytonutrients contained in these foods (Rapisarda et al. 1999). We have undertaken this study to evaluate the antioxidant potential of goldenberry, pepino and passiflora fruit pulp. The antioxidant activity of these fruit species were assessed by means of DPPH test, Fe^{+2} chelating activity (%) and H_2O_2 inhibition activity (%) and the resulting values were correlated with each one of these classes of antioxidant compounds. All fruit species tested in our study showed an evident antioxidant effect (Table 2).

When this three exotic fruits were evaluated in point of fruit antioxidant contents, it was observed that passiflora fruits had higher values than the others. Passiflora (1.273) and Pepino (1.363) fruits showed highest values concerning with EC50. Goldenberry was found the lowest with the value 0.950. The highest values in point of AE and Fe chelating activity and H_2O_2 inhibition were obtained from passiflora fruits, and it was followed by pepino and goldenberry fruits, respectively (Table 2). Ramadan and Moersel (2007) determined that the antioxidant activity of goldenberry juices was assessed by means of DPPH test and the resulting values were correlated with each one of these classes of antioxidant compounds. All goldenberry juices tested in their study showed an evident antioxidant effect. Pietro et al. (2000) and Perry (1980) told that *Passiflora peruviana* is a medicinal plant widely used in folk medicine as anticancer, antimycobacterial, antipyretic, immunomodulatory, and for treating diseases such as malaria, asthma, hepatitis, dermatitis, diuretic and rheumatism. Hot water extract of *P. peruviana* is often used to prepare health beverages. Wo et al. (2004) determined that ethanol extracts of *P. peruviana* possess good antioxidant activities, and the highest antioxidant properties were obtained from the 95% EtOH PP. On the other hand, Sunitha and Devaki (2009) analyzed to the extract of *Passiflora edulis* Sims leaves for its antioxidant (1,1-diphenyl-2-picryl hydrazyl radical reducing power methods) and phytochemical analysis. The extract was found effective against the antioxidant test models exhibiting an IC_{50} value of 875 ± 87.83 (mean±STD) µg/ml and showed strong potential antioxidant activity in both assays. Rudnicki et al.(2007) presented that the *P. edulis* hydroalcoholic leaf extracts possess in vitro and ex vivo antioxidant activity against oxidative protein damage and should be considered as new sources of natural antioxidants. Vasko et al. (2008) chosen the seventeen fruits, belonging to seven botanical families, which are commonly cultivated and consumed in Ecuador for their study. And then analysed these fruit for their antioxidant capacity, using three different methods (DPPH•, FRAP and $ABTS^{\bullet+}$). At the end of the research they found that, goldenberry, passion fruit and sweet pepino antioxidant capacity was 0.7-0.5 and 0.3 µmol Trolox/g sample FW, respectively.

As a result, Passiflora fruits had the highest total antioxidant activity, followed by pepino and goldenberry. Therefore, in terms of antioxidant activities passiflora fruits are more important.

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