Comparative Study of Antioxidant Activity of Fruit, Peel and Pulp of Six Albanian Fresh Fig (*Ficus carica*) Varieties

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Abstract

Evidence on naturally occurring phenolic compounds and their antioxidant properties in fruits is growing. Also several works have proven the presence of polyphenols in fig fruit, and suggesting figs as important constituents of a rich diet. The study aims to compare the antioxidant activity of peel and pulp of six autochthonous fresh fig varieties grown in Albania, which are popular for fresh consuming in local markets.
First and second crop of selected fig varieties "Lashti", "Patellxhan", "Shengjinas Zi" dark types, and "Shengjinas Bardhe", "Nof Bardhe", "Durrsak" light types were compared for total polyphenols, anthocyanins, flavonoid content, and antioxidant capacity using ABTS (2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid) radical scavening assay, and result expressed as acid ascorbic equivalents (AAE).
Phenolic content resulted more concentrated in peel up to 165.48 mg gallic acid equivalent/100 g fresh weight (FW), while dark varieties had higher antioxidant activity up to 12.97 mol AAE /100 g FW.
The findings of this work may serve as guide for fresh consuming for selected fig varieties, in terms of antioxidant substances. "Shengjinasi Zi" variety had the highest antioxidant capacity, and considerating its functional properties, this variety may be suggested as a potential for developing in local fresh fig market.

KEYWORDS: Antioxidant activity, autochthonous fig, flavonoid, polyphenols.

1.INTRODUCTION

Fig (*Ficus carica* L.) is one of the most common fruits in the Mediterranean region commonly grown especially in warm and dry climates. In Albania figs are widespread species, from exploration and collection of fig population results that in our country exist 88 different biotypes, while fig production is 18378 ton of total fruit tree, and occupies 13.66 % of total fruit trees (Hodaj et al., 2014).
Figs are important seasonal fruit in many countries mainly consumed fresh, either peeled or not. These fruits have forms, colors, tastes, technological and therapeutic properties that differ from a variety to another and generally given name in reference to their shape, color and the region where it is cultivated the most (Meziant et al., 2015).
The figs are a good source of flavonoids and phenols compounds that attribute to nutritional value. The functionality of these compounds is mainly expressed in their scavenging free oxygen radicals, which are involved in many pathological conditions (Briviba & Sies 1994; Tadić *et al*. 2008; Hasan *et al*. 2010). Phenolic compounds possess a wide spectrum of biochemical properties and can also have a beneficial effect in preventing the development of diseases like cancer and cardiovascular diseases (Lattanzio, 2003). Also a number of studies have shown that the presence of phenolics in

fig fruit can be particularly important for consumers, because besides antioxidative role effects have antimutagenic or anticarcinogenic, antiinflammatory, or antimicrobial activities (Eberhardt et al., 2000; Kim et al., 2000). Solomon et al. (2006) discussed for the frst time the differences in polyphenol composition between pulp and peel of six commercial fig varieties.

The growing interest in fruits as source of phenolic compounds indices us to evaluate and compare total phenols, flavonoids, anthocyanins content, and total antioxidant activity of some local figs, also contributing possibilities to literature, as there are few reports dealing with the phenolic contents on Albanian fig varieties.

2.MATERIAL AND METHODS

2.1. Plant material

First and second crop of mature autochthonous figs were randomly collected ("Lashti", "Patellxhan", "Shengjinas Zi" dark types, "Shengjinas Bardhe", "Nof Bardhe", and "Durrsak" light types) in the period June-August of 2015 from different regions of Tirana, Elbasan and Berat. After immediate transportation to Laboratory of Agrifood Technologies, the whole fruit and pulp were homogenized using Waring Blender (Commercial, USA), and peel with Ultra Turrax (IKA GmbH, GR).

2.2Preparation of Extracts

In a test tube were weighted 3 ± 0.001 g homogenized samples of whole fruit, pulp, and peel and extracted with 10 ml of 80% (v/v) aqueous-methanol at room temperature, for 1 minute using Ultra Turrax (IKA GmbH, GR) and then centrifuged for 30 min at 3500 rpm (Eba 21, Hettich). This procedure was repeated three times and the supernatants were collected for further analysis.

2.3 Chemicals.

All chemicals used were analytical grade, and purchased from different sources (Fisher, Sigma-Aldrich, Fluka, Merck, and VVR).

2.4 Analyses

Moisture content was determined following AOAC ref. 934.06 (AOAC, 2000).

Determination of Polyphenols

The total polyphenolic content was determined with Folin-Ciocalteu reagent accorrding to Singleton and Rossi's method with some modification using gallic acid as standard. Total fig phenolics extract was expressed on a fresh weight basis as milligrams of gallic acid equivalence (GAE) per 100 g of fresh weight (FW).

Determination of Flavonoids

The total flavonoids content was determined colorimetrically as described previously by Zubair and others at 510 nm. The flavonoid content was determined by a (+)-catechin standard curve and expressed as mean of milligrams of (+)-catechin per 100 g of FW of fruit.

Determination of Anthocyanins

Total anthocyanins content was determined according to the pH differential method (Cheng and Bren, 1991). Absorbance was measured at 520 and 700 nm and expressed as

cyanidin-3-glycoside (molar extinction coefficient 26900 and molecular weight of 449.2) equivalents per 100 g of FW of fruit.

$$A = (A_{520}–A_{700})_{pH\ 1.0} -(A_{520}–A_{700})_{pH\ 4.5.} \text{ (Eq. 1)}$$

Determination of antioxidant activity with ABTS radical scavenging assay

The antioxidant capacity of extracts was determined as ABTS radical scavenging activity (Re R. *et al*., 1999) The ABTS [2,2-azinobis-3- ethylbenzothiazoline-6-sulfonic acid] radical cation was produced by mixing ABTS with potassium persulfate and the mixture was kept for 16 h in the dark at room temperature before use. For the analysis, the reagent was diluted in ethanol until the absorption at 734 nm was 0.7± 0.02. A 10 µl of extract was mixed with 990 µl of ABTS reagent. The absorption was measured after 6 min of addition using spectrophotometer (Bichrom LTD, UK). The ABTS radical scavenging activity percentage of the extract was compared to ascorbic acid which was used as standard was expressed as mol AAE/100 g FW of sample.

3. RESULT AND DISCUSSION

Fig varieties included in the study (Fig.1) represent local figs, and the varieties included were the following: “Lashti”, “Shengjinas Zi”, “Patellxhan”, which are dark type figs, middle-sized, purple and black colour of skin, with slightly rose pulp, their taste is sweet, while “Shengjinas Bardhe”, “Nof Bardhe”, and “Durrsak” are light type of fig with green skin, slightly rose pulp, middle sized, sweet-tasting and juicy.

Figure 1: Autochthonous fig varieties, respectively 1-Lashti, 2-Shengjinas Zi, 3-Patellxhan, 4-Shengjinas Bardhe, 5-Durrsak, 6-Nof Bardhe (Photo by L. Hoxha).

In the Table 1 are presented name of varieties, region where are taken, date of collection, the weight of fig varieties taken under study, also is included the moisture content.

Table 1. Some characteristics of fig varieties, place and date of collection

Variety	Region	Collection date	Fruit Weight (g)	Moisture content % (Mean ± SD)	Collection date	Fruit Weight (g)	Moisture content % (Mean ± SD)
Lashti	Berat	22-06-2015	78	82.69 ± 0.011	13.08.2015	48	76.97 ± 0.02
Shengjinasi Zi	Tirane	28.06.2015	150	82.27 ±0.103	17.08.2015	91	77.32 ± 0.05
Patellxhan	Berat	26.06.2015	86	81.73 ± 0.128	17.08.2015	52	77.24 ± 0.11
Shengjinas Bardhë	Tirane	06.07.2015	131	81.65 ± 0.159	25.08.2015	85	77.54 ± 0.07

Nof Bardhe	Elbasan	07.07.2015	87	81.49 ± 0.902	29.08.2015	60	78.60 ± 0.48
Durrsak	Tirane	06.07.2015	82	79.40 ± 0.048	25.08.2015	45	76.28 ± 0.02

Moisture content of first crop ranged 79.4-82.69 %, were dark types resulted with the highest value (Lashti had highest content 82.69%), compared to light type (Durrsak had lowest content 79.40%). While second crop ranged 76.28-78.60% resulting thus with lower moisture content, related this with the smaller size of fruit.

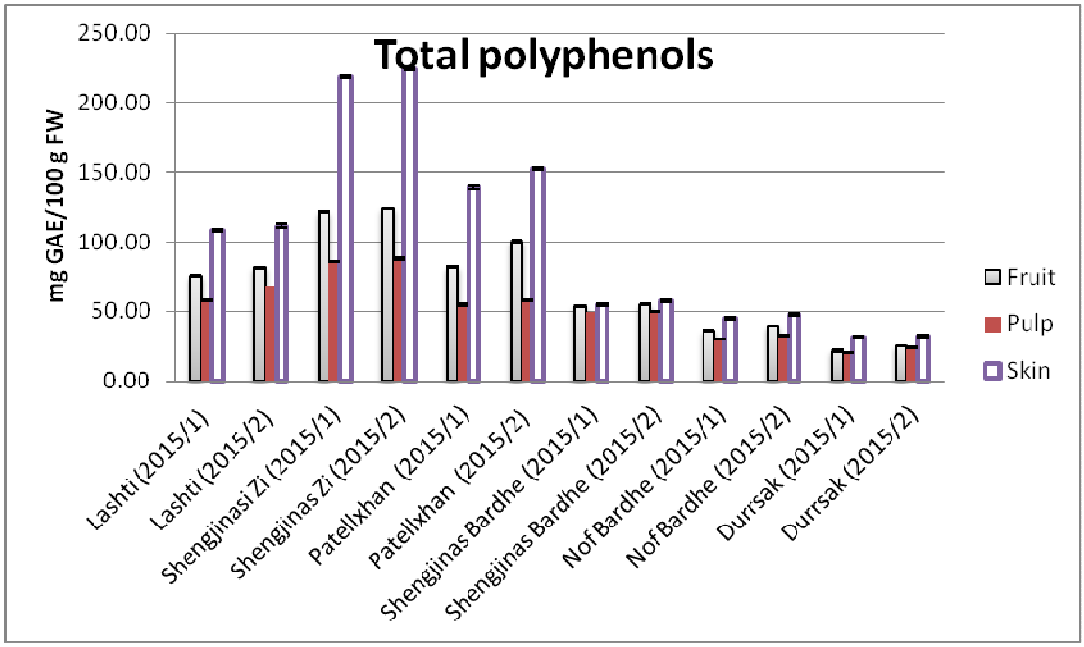

Figure 2: Total polyphenolic content in fig cultivars (expressed in mg GAE/100g FW)

In the figure 2 is shown total phenolic content (TPC) distribution for first and second crop of six fig varieties studied, and the results ranged from 20.53-224.42 mg GAE/100 g of fresh weight (FW). As it was expected from other studies resulted that dark types of fig had higher phenolic content, than light types. The presence of polyphenols in pulp (20.53-87.74 mg GAE/ 100 g FW) were lower compared to whole fruit (21.67-123.77 mg GAE/ 100 g FW), and the major contributor was the skin for dark types of fig fruits ranged 108.58-224.42 mg GAE/100g FW, while light types of figs showed 31.82-57.25 mg GAE/100g FW. It was noted that second crop had slightly higher values compared to first crop.

Our results are in agreement with those reported by other authors. Solomon et al. (2006) who outlined data with a larger range than ours (from 49 and 281 mg GAE /100 g FW). As well, Caliskan and Polat (2011) obtained results with a smaller range than ours (19.4 to 74.4 mg GAE/100 g of fresh weight), also Slatnar et al. (2011) measured much lower phenolic content compared to our results (about 7.5 mg GAE/100 g FW) when using methanol as extraction solvent.

When compared to other fruits, fresh figs can be considered as good source of total phenolics as many researcher have studied various fresh fruits and their different varieties, comparing to grapes where phenolic content ranged from 47.3 to 72 mg GAE/100 g FW reported by Carranza-Concha et al. (2012).
Based on result obtained Shengjinasi Zi a dark fig variety had presents the highest level of phenolic compounds, while the light fig variety Nof Bardhe had the lowest one.

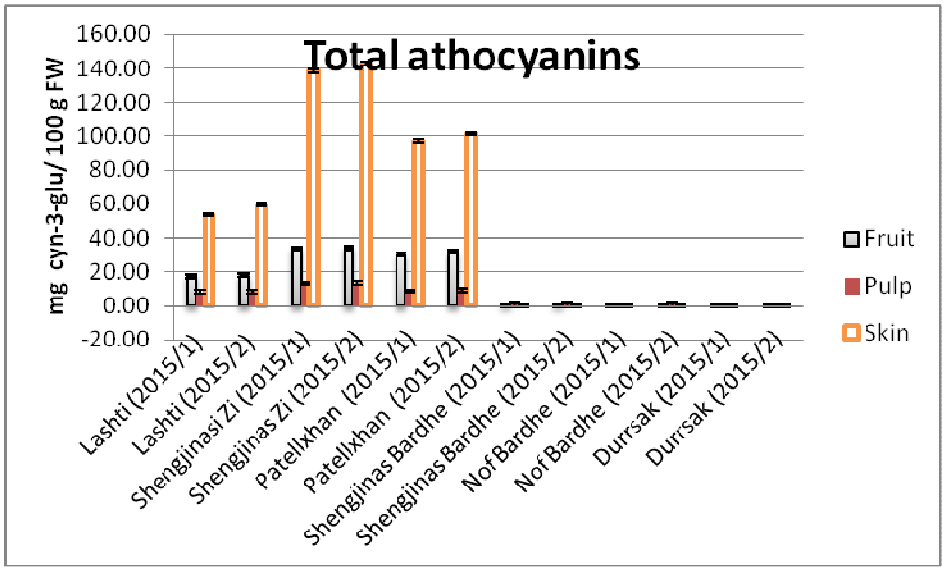

Figure 3: Total anthocyanins content in six fig varieties expressed as mg cyaniding-3-glucoside/100g FW

In Figure 3 are shown result of total anthocyanins expressed as equivalent of cyanidyn-3-glucoside. It was noted that at light varieties were not the presence of anthocyanins, while dark types of figs had smaller amounts of anthocyanins in pulp (0.25-13.48 mg C3G/100g FW), while in fruit were in larger range (0.05-34.34 mg C3G/100g FW), and the skin had the higher content (0.0-142.83 mg C3G/100g FW). Furthermore, the first crop had the lowest content than second crop, and the variety that had highest content was Shengjinas Zi.
Accordingly, dark fruit skins had more anthocyanins compared to lighter varieties that were not found the presence of anthocyanins.

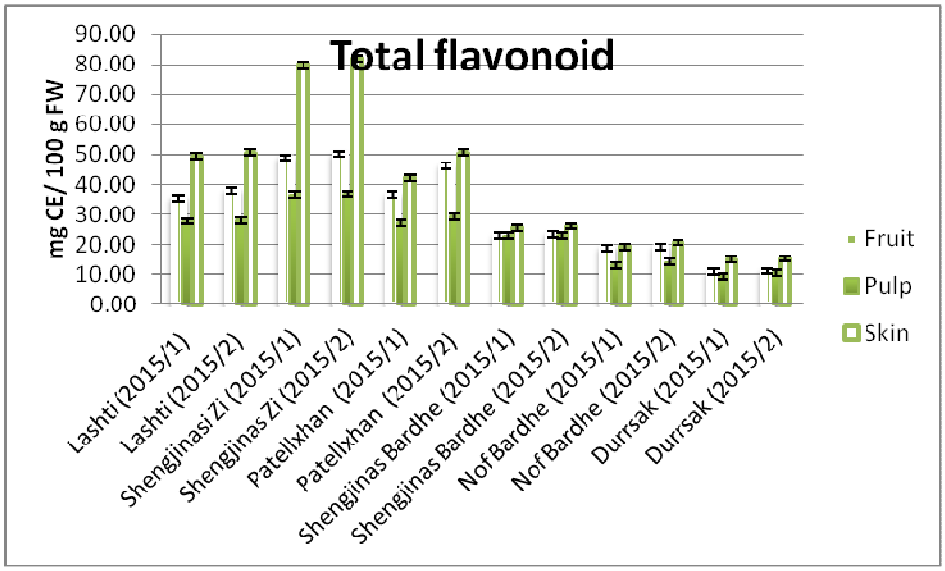

Fig. 4: Total flavonoid content expressed as mg (+) catechin equivalent/100g FW

Total flavonoid content of the six fig varieties was measured colorimetrically and found to be higher in the dark varieties compared to the lighter ones (Figure 4.). Accordingly, flavonoids was located in the fruit skin, where the highest values resulted in skin of second crop of Shengjinas i Zi (81.99 mg CE/100g FW), and the lowest content in skin showed first crop of Durrsak (14.91 mg CE/100g FW). The total flavonoid content evaluated in the whole fruit resulted higher at second crop of Shengjinasi Zi variety (50.16 mg CE/100g FW), and the lowest value showed first crop of Durrsak (10.79 mg CE/100g FW). It was noted that in pulp there were differences between dark and white types, and the highest value resulted at second crop of Shengjinasi Zi variety (36.87 mg CE/100g FW) and the lowest content had first crop of Durrsak variety (9.33 mg CE/100g FW).

According to Solomon et al. (2006), total flavonoid content of six fresh fig varieties studied was ranged from 2.1 and 21.5 mg catechin equivalent/100 g FW, whereas in our study values were somewhat higher ranging from 9.33-81.99 mg catechin equivalent/100 g FW. Instead our results were more near in values reported by Del Caro and Piga (2008), who showed that fresh light fig of San Pietro variety contained 71.5 mg CE/100 g FW. The authors noticed that among the color-group varieties, no significant difference was found, instead in our study the dark type varieties showed higher content than light type varieties.

In the study of Marinova et al. (2005) had investigated and summarized the flavonoid content in light-colored fruits, as following: pear (69.9 mg CE/100 g FW), yellow apple (34.8 mg CE/100 g FW), green apple (40.4 mg CE/100 g FW), peach (15.0 mg CE/100 g FW), sweet cherry (19.6 mg CE/100 g FW), white grape (36.5 mg CE/100 g FW) and fig (20.2 mg CE/100 g FW). In our study total flavonoid content in the whole fig fruit resulted up to 50.16 mg CE/100 g FW that might suggested that fig might serve as a supplement of flavonoids in our diet.

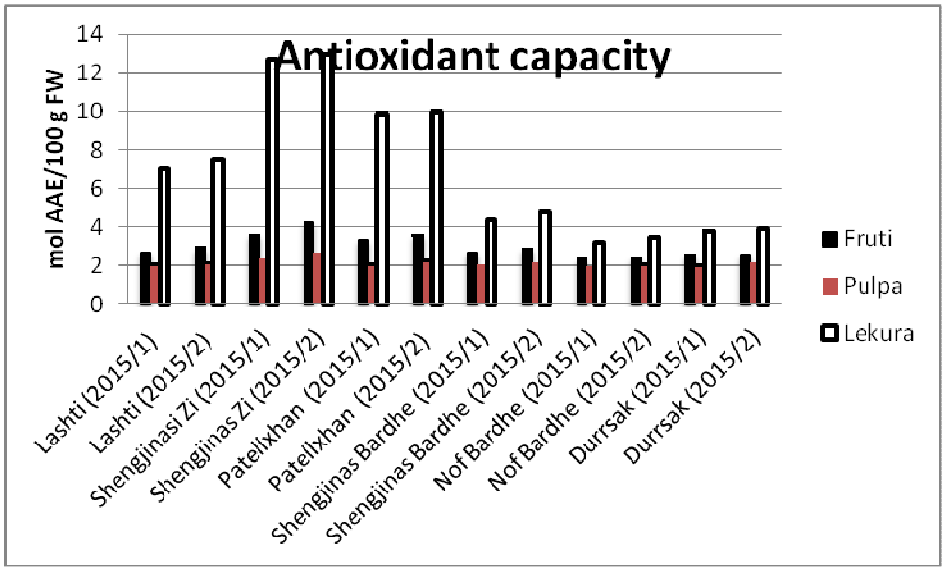

Fig. 5: Antioxidant capacity expressed as mol ascorbic acid/100g FW

Total antioxidant capacity were measured with ABTS assay and ranged from 2.003 to 12.97 mol acid ascorbic equivalent (AAE)/100 g of FW (fresh weight). Extracts of dark type fig varieties (Figure 5), had higher antioxidant activity with about 3 fold higher compared to light variety tested. Shengjinasi Zi fig variety expressed higher values of antioxidant capacity (2.35-12.97 mol AAE/ g FW), and Nof Bardhe had lower antioxidant capacity (2.003-3.49 mol AAE/ g FW).

The skin of all analyzed varieties was the major contributing tissue to the total antioxidant activity (3.18-12.97 mol AAE/ g FW), compared to the pulp (2.003-2.66 mol AAE/ 100 g FW) and the whole fruit (2.39-4.24 mol AAE/ g FW).

Second crops contained somewhat higher values (2.06-12.97 mol AAE/ g FW) from one part of fruit to other, compared to first crop (2.003-12.70 mol AAE/ g FW). This could be explained by the fact that the fruit develop in warmer, drier and sunnier environmental conditions than the first crop. These weather conditions could be the trigger for higher phenolic synthesis.

4. CONCLUSION

The present study showed that between fig varieties were differences in phenolic content, where dark skin contain higher levels of polyphenols, anthocyanins, and flavonoids accompanied by higher antioxidant activity compared with lighter skin fig varieties. Furthermore variations existed from one fruit fraction to another where the main distributions were in skin. Also variation were between first and second crop, where second crop had higher amount, related this with fruits developed in warmer weather conditions.

The variability observed in the phenolic composition among the analysed varieties gave us evidence on the influence of not only varietal factor, also other factors, such as growing conditions, geographical origin, environmental conditions, maturity etc.

Based on result of this study could be concluded that selected figs may serve as good source of natural antioxidants, which are of a point of interest because of their health benefits and can be considered as a functional food or at least as a functional food

ingredient. “Shengjinasi Zi” variety had the highest results of antioxidant capacity, and could be considered as the best for fresh fig consuming, also this may be indicative for a potential development in fresh fig market. Thus, the paper give mainly information for the total amounts of polyphenolic compounds in whole fruit, peel and pulp of six fresh autochthonous Albanian figs varieties, however the work should be completed by the use of more numerous varieties and the determination of phenolic content with more accurate methods (liquid chromatography).

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