International Journal of Bioinformatics and Biomedical Engineering
Vol. 1, No. 3, 2015, pp. 237-243
http://www.aiscience.org/journal/ijbbe

Varietal Influence on Biological Properties of Algerian Light Figs (*Ficus carica* L.)

Leila Meziant, Fairouz Saci, Mostapha Bachir Bey, Hayette Louaileche*

Laboratory of Applied Biochemistry, Faculty of Life and Natural Sciences, University of Bejaia, Bejaia, Algeria

Abstract

Figs are worldwide distributed and highly consumed at both fresh and dried state, especially in Mediterranean countries. They are known to provide many dietary elements and beneficial phenolic compounds that have good antioxidant properties. The present study aimed to investigate the influence of fig variety on the phenolic content and on two *in vitro* biological activities. Results showed significant differences among the six analyzed varieties for phenolic (217 to 342 mg GAE/100 g DW), and flavonoid contents (11.13 to 19.20 mg QE/100 g DW). The varietal influence was also obtained for the nitric oxide radical (NO°) scavenging activity (235.13 to 624.45 mg QE/100 g DW) and iron chelating potential (24.19 to 62.58%). Highly significant correlations were found between the NO° scavenging activity and contents of phenolic compounds (r = 0.72), and flavonoids (r=0.84), but no correlation was obtained for the ferrous chelating activity.

Keywords

Fresh Fig, Light Fig, Variety, Phenolic Compounds, Antioxidant Activity

Received: August 9, 2015 / Accepted: September 5, 2015 / Published online: September 25, 2015

1. Introduction

Figs are the fruits of fig tree that belong to the genus *Ficus,* which counts more than 800 species, and the consumed figs are from the *Ficus carica* species (Woodland, 1997). The fig is a delicious and nutritive fruit and has medicinal properties that may reduce the risk of cancer and heart disease (Vinson, 1999). Figs are especially rich in dietary fiber, trace minerals, antioxidant polyphenols, sugars, organic acids and volatile compounds that provide a pleasant characteristic aroma (Slatnar *et al.,* 2011).

Figs are produced all over the world but, those of the Mediterranean region are specifically remarkable for their quality and taste. Algeria ensures more than 10% of the worldwide production (FAO STAT, 2013). 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. The Technical Institute of Fruit-bearing Arboriculture in Algeria counts nearly 40 varieties, including comestible varieties and caprifig ones.

The nutritional values of the figs have been attributed to many factors, particularly the phenolic compounds that are one of the main responsible of the positive health effects of figs. The phenolic compounds are essential substances for plants that have several functions, among which the antioxidant and protective against external aggressors are the most important. In addition, the phenols have other functions: antibiotics, natural pesticides, UV-protectors, etc. The natural properties of phenolics are the basis of their growing success in food industries and in cosmetics. Taking all this into account, the food industry is creating an increasing quantity of products called “fortified” or “nutraceuticals” and dietary supplements are based on these substances (Russo, 2014).

Phenolics are wide spread in nature. Despite this almost

* Corresponding author
E-mail address: haylouaileche@yahoo.fr (H. Louaileche)

ubiquity, experimental evidence has demonstrated that some of them can work as useful markers of the botanical origin of several plant food products. Additionally, within each species, the nature of these compounds can vary from organ to organ and several other factors can contribute to the variability in the phenolic composition, such as cultivars and genetics, geographical origin, maturity, and storage conditions (Spanos and Wrolstad, 1992).

Interest in fruits as source of natural substances incited us to determine the phenolic content of some local light-skinned fig varieties and to investigate their biological activities *in vitro*, in order to assess the inter-varietal influences. The present work represents an evaluation of local natural resources and a contribution to the knowledge of the Algerian fig varieties.

2. Material and Methods

2.1. Sample Preparation

Six varieties of fresh figs were used: *Abearous* (turbinal, slightly flattened fruit with short neck, green skin and red pulp), *Azegzaw* (small spherical fruit with very short stalk, smooth thin green skin and red pulp), *Elbakor* (pyriform fruit, with long neck, short stalk, thick green skin and pink pulp), *Tahyounte* (flattened fruit without neck, with yellow skin and yellow-white pulp), *Tamriwthe* (pyriform fruit with small neck, thin yellow-green skin and red pulp) and *Taghanimte* (turbinal fruit with medium neck, long stalk, thin green skin and pink pulp). These varieties were harvested in the region of Beni-Maouche (Bejaïa department, north Algeria). The fruits were firm and mature. The samples were cut into small pieces, lyophilized (Alpha 1-4 LD_{plus} Christ, Osterode, Germany) and ground using an electrical grinder. The powders were stored at -18°C.

2.2. Preparation of Extracts

The fig powder (0.1 g) was extracted with 10 ml of acetone 60%. The tubes were incubated in a water-bath with agitation (WB 22, Memmert, Osterode, Germany) at 45°C for 90 min. After centrifugation at 5000 rpm for 10 min, the supernatant was filtered and the recovered extract was used for the different analyses.

2.3. Total Phenolic Content

Phenolic content was determined according to Singleton and Rossi (1965) and Velioglu *et al.* (1998). Fig extract (200 µl) was added to 750 µl of Folin-Ciocalteu reagent, diluted 10-fold. After 5 min, 400 µl of sodium carbonate (7.5%) were added. The reaction mixture was incubated at room temperature. After 90 min, the absorbance of the mixture was read at 720 nm using a spectrophotometer (UVLine 9400, Secomam, Alès, France). Phenolic content was calculated from the calibration curve of gallic acid. Results were expressed as milligrams per 100 g of dry weight (mg GAE/100 g DW).

2.4. Flavonoid Content

Flavonoid content was determined according to Djeridane *et al*. (2006). Equal volumes of the extract and a solution of aluminium chloride (2%) were mixed. After incubation for 15 min at room temperature, absorbance was read at 430 nm. The results calculated from the calibration curve of quercetin, were expressed as milligrams per 100 g of dry weight (mg QE/100 g DW).

2.5. Scavenging Activity Against Nitric Oxide

The NO° radical scavenging activity was determined according to Gorinstein *et al.* (2004). A volume of 500 µl of fig extract was added with an equal volume of 10 mM sodium nitroprusside. The reaction mixture was incubated at 25°C during 150 min. One milliliter of Griess reagent was added, and the absorbance was measured at 542 nm after 30 min incubation at room temperature. The scavenging activity was calculated from the calibration curve of quercetin. Results were expressed as milligrams per 100 g of dry weight (mg QE/100 g DW).

2.6. Iron Chelating Activity

The chelating capacity of the fig extracts was determined according to Decker and Welch (1990). Extract (250 µl) was added to 25 µl of iron (II) chloride (2 mM) and 800 µl of distilled water. After 5 min, 50 µl of ferrozine (5 mM) were added. After 5 min, the absorbance of the mixture was read at 562 nm. Results were calculated according to the following formula:

$$\text{Chelating activity (\%)} = [1-(A_1-A_2)/A_0] \times 100$$

where: A_0 is the absorbance of the control, A_1 is the absorbance of the mixture containing the extract and ferrozine and A_2 is the absorbance of the mixture containing the extract without ferrozine.

2.7. Statistical Analysis

All analyses were carried out in triplicate and the results were expressed as mean ± standard deviation. The analysis of variance (ANOVA) with LSD (Least significant difference) test was performed using STATISTICA 5.5 software, to find out the significant differences ($p<0.05$) between the analyzed varieties.

3. Results and Discussion

3.1. Total Phenolic Content

The presence of phenolics in food and especially in fruits can be particularly important for consumers, because of their beneficial health properties. Besides antioxidant effects, phenolic compounds possess a wide spectrum of biochemical properties and can also prevent the development of disorders such as cancer and cardiovascular diseases (Slatnar *et al.*, 2011).

Results obtained for fresh figs (figure 1) showed that phenolic content varies from 217 to 342 mg GAE/100 g of dry weight (57.7 to 89.3 mg GAE/100 g of fresh weight). The variety *Azegzaw* presents the highest level of phenolic compounds and *Tahyounte* the lowest one. The significant differences observed among the analyzed varieties gave us evidence on the influence of varietal factor on the phenolic contents. An exception was noted for *Tamriwthe* and *Abearous* varieties that have similar phenolic contents (about 263 mg GAE/100 g DW).

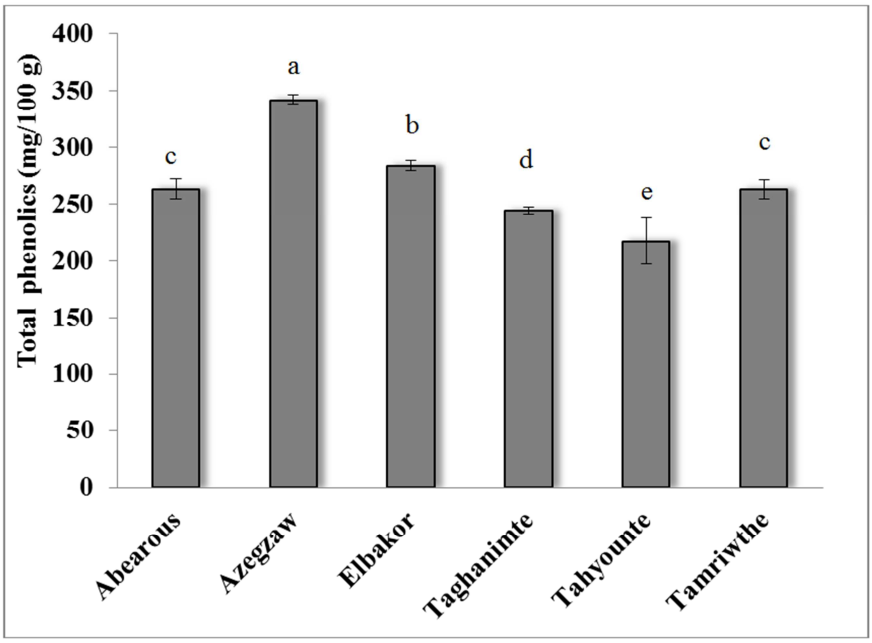

Figure 1. Total phenolic contents of fresh figs.

Vertical bars present the standard deviation (three repetitions). Results with different letters are statistically different at $p<0.05$ as measured by LSD test.

Our results are in agreement with those reported by Nakilcioglu and Hisil (2013) who outlined data ranging from 198.8 to 307.6 mg GAE/100 g DW for ten fresh fig varieties, and those of Solomon *et al.* (2006), with a larger range of values (49 and 281 mg GAE /100 g of fresh weight), when analyzing six varieties of fresh figs of different colours. As well, Caliskan and Polat (2011) obtained similar results varying from 19.4 to 74.4 mg GAE/100 g of fresh weight. 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. Extraction efficiency of phenolic compounds can be the cause of the differences between results. In fact, there is no satisfactory solvent extraction method suitable for the isolation of all classes of phenolics because of their chemical nature which vary from simple structure to highly polymerized ones (Shahidi and Naczk, 2004). It is worth noting that, the extraction conditions of phenolic compounds in figs were optimized and acetone is the most suitable solvent in the case of figs (Bachir Bey *et al.*, 2013; 2014a; 2014b). Results obtained in the present study are much lower than those indicated by Vinson *et al.* (2005). They reported that fresh figs contained about 486 mg of catechin equivalent per 100 g FW of total phenols, but the use of catechin standard makes the quantitative comparison of the results difficult.

Total phenolic contents of various fresh fruits and their different varieties have been studied by many researchers. Carranza-Concha *et al.* (2012) reported that phenolic content in grapes ranged from 47.3 to 72 mg GAE/100 g FW. Benmeddour *et al.* (2013) noticed that Algerian date varieties provide 167 to 709 mg GAE/100 g FW. When compared to other fruits, fresh figs can be considered as good source of total phenolics.

3.2. Flavonoid Content

Flavonoids are pigments having an important role in the growth and defense of plants. Some biological activities like, anti-inflammatory, anti-allergic, anti-tumor and immune-

modulatory activities are attributed to flavonoids. These compounds are brought essentially by fruits and vegetables.

Results obtained for the tested fig varieties (Figure 2) ranged from 11.13 to 19.20 mg QE/100 g DW (2.98 to 5.01 mg QE/100 g FW). The highest content is recorded for *Azegzaw* variety and the lowest one was that of *Tamriwthe* variety. The varietal influence is not marked on the flavonoid content, as we found that the differences measured between the majority of the varieties analyzed are not significant at $p<0.05$.

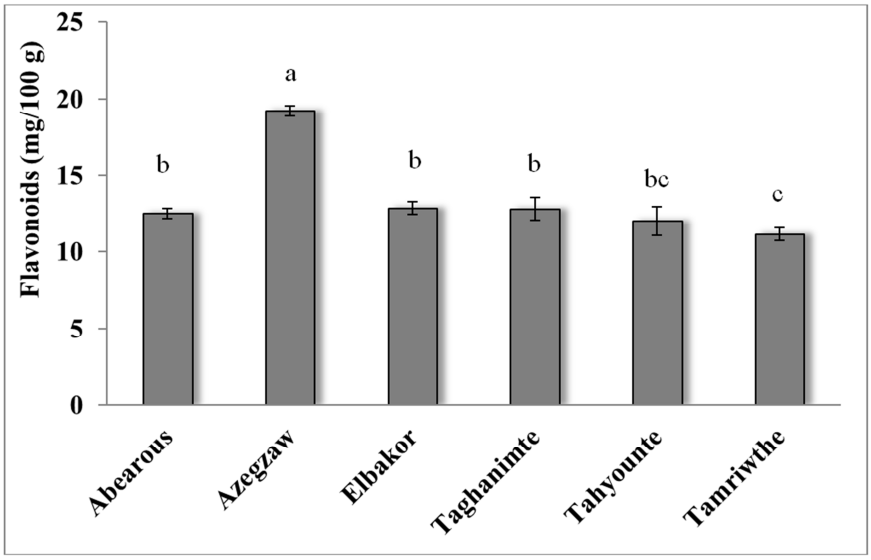

Figure 2. Flavonoid contents of fresh figs.

Vertical bars present the standard deviation (three repetitions). Results with different letters are statistically different at $p<0.05$ as measured by LSD test.

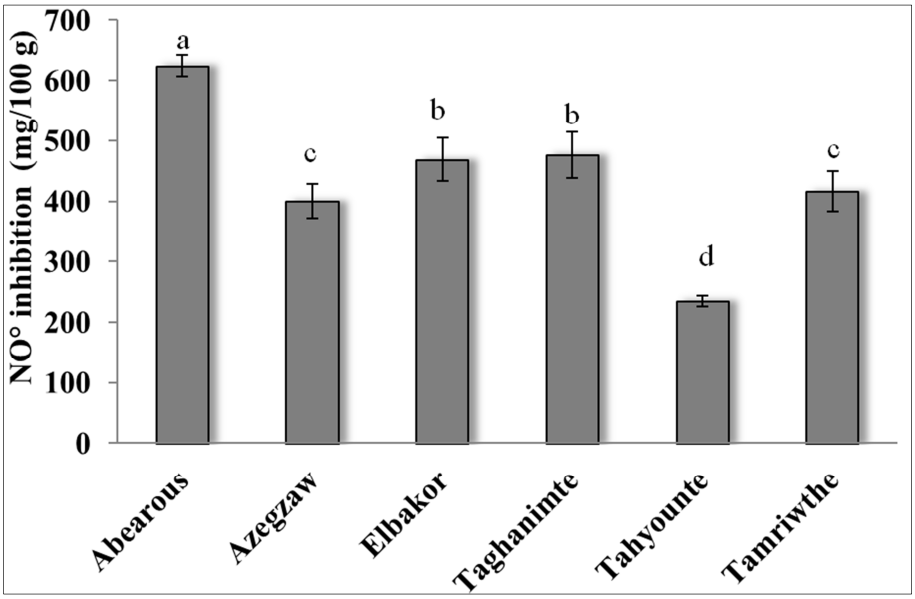

Figure 3. Nitric oxide radical scavenging activity of fresh figs.

Vertical bars present the standard deviation (three repetitions). Results with different letters are statistically different at $p<0.05$ as measured by LSD test.

According to Solomon *et al.* (2006), total flavonoid content of six fresh fig varieties was ranged from 2.1 and 21.5 mg catechin equivalent/100 g FW. The authors noticed that among the color-group varieties, no significant difference was found. A much greater value was mentioned by Del Caro and Piga (2008) who showed that fresh light fig of 'San Pietro' variety contained 71.5 mg/100 g FW. The results obtained in this investigation are lower than those reported in literature. The differences might be due to various factors, such as variety, growing conditions (age of the tree, use of fertilizers, caprification practice), geographical origin, environmental conditions (soil type, climate, amount of sunlight received).

In an investigation that summarized the flavonoid content in light-colored fruits, Marinova *et al.* (2005) outlined the following data: 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). Our results suggested that fig might constitute a supplement of flavonoids in our diet and an additional protection for our health.

3.3. Nitric Oxide Inhibitory Activity

Nitric oxide radical is an important molecule of signalization in the cardiovascular system. But pathologic accumulation of this nitrogen reactive species, *in vivo*, had negative effects on the health. NO° radical played an important function in the mechanism of inflammation (Moncada *et al.*, 1991), an extract having an inhibitory activity of this radical can be used as a source of anti-inflammatory substances.

NO° radical inhibitory activity results are presented in figure 3. Inhibition activity of the fresh fig extracts ranged from 235.13 to 624.45 mg quercetin equivalent per 100 g DW (62.54 to 131.88 mg QE/100 g FW). The best inhibitory activity has been recorded for *Abearous* variety, and the lowest one is noted for *Tahyounte*. Significant differences are observed between the analyzed varieties at $p<0.05$, except *Elbakor* and *Taghanimte* varieties (472 mg/100 g DW), and *Tamriwthe* and *Azegzaw* varieties which exhibited an average activity of 408 mg/100 g DW. Inter-varietal differences of the NO° scavenging activity were found in the current study. This variability might be due to differences in the phenolic composition.

3.4. Iron Chelating Activity

The chelating capacity of metals of transition is an important mechanism of the antioxidant activity. Free metals can catalyze reactions of oxidation and contribute to free radical creation. Ability to chelate Fe^{2+} or other metals, such as copper, is thus an important antioxidant property to measure.

The iron chelating capacity of fig extracts is presented in figure 4. The results varied from 24.19%, showed by *Elbakor* variety, to 62.58% recorded for *Tamriwthe* variety. Significant differences are noted among the analyzed varieties, except for the varieties *Tamriwthe* and *Taghanimte* that present similar chelating potential (about 62%).

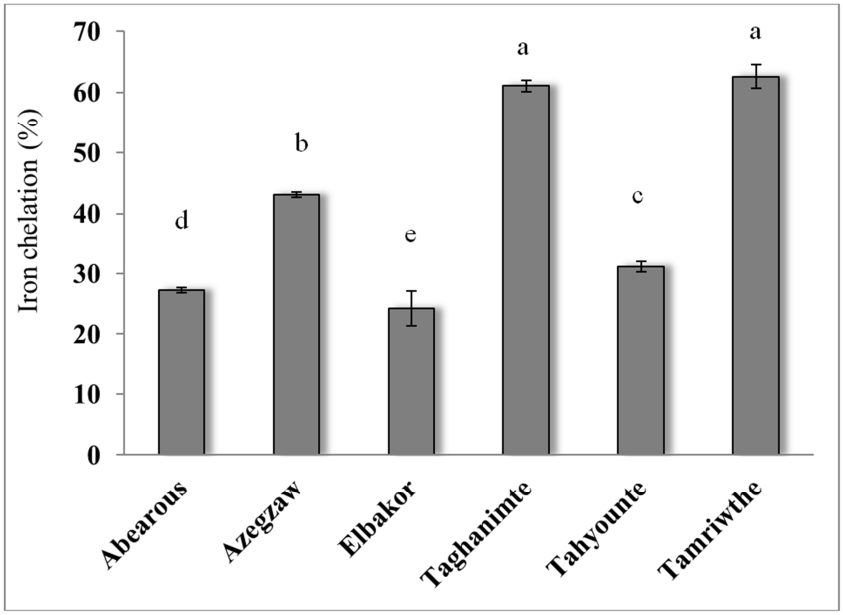

Figure 4. Iron chelating activity of fresh light fig varieties.

Vertical bars present the standard deviation (three repetitions). Results with different letters are statistically different at $p<0.05$ as measured by LSD test.

It is worth noting that primary antioxidants act as radical scavenging compounds: they can inhibit the initiation and stop propagation of oxidation chain-reactions. Secondary antioxidants (preventive) proceed by suppression of the factors of formation of free radicals (Lim *et al.,* 2007).

From the studied varieties, the iron chelating activity is more pronounced than the NO° inhibiting activity for the variety *Tamriwthe*, so the figs belonging to this variety had preventive secondary antioxidants. Contrary fact is noted for *Abearous, Elbakor* and *Tahyounte* varieties are sources of primary antioxidants more than the other antioxidants. However, the varieties *Azegzaw* and *Taghanimte* showed high activities for both NO° inhibition and iron chelation; as a result, they can be considered as a good source of both primary and secondary antioxidants.

3.5. Correlations

The correlation coefficients between the antioxidant capacities and, the total phenolic and flavonoid contents of fig varieties were determined (Table 1). Highly significant, positive correlation ($p<0.001$) was obtained between total phenolic content and flavonoids ($r = 0.87$). In the same way, significant positive relationships were found between the NO° inhibiting activity and the total phenolic content ($r = 0.72$), on a hand, and the flavonoids ($r = 0.84$), on the other hand. Flavonoids constitute an important group among phenolic compounds; the presence of free hydroxyl groupings in their structure is involved in their capacity to trap the free radicals (Pokorny *et al.,* 2001).

Table 1. Correlation matrix between phenolics, flavonoids and antioxidant activities of fig varieties

Parameters	Phenolics	Flavonoids
Flavonoids	0.87***	
NO° inhibition	0.72***	0.84***
Iron chelation	-0.11	-0.12

Coefficients of correlation followed by *** are significant at $p<0.001$.

The iron chelating capacity was correlated neither with phenolic compounds nor with flavonoids, implying that these compounds may not be responsible for metal chelating ability of the tested extracts. Many metal chelating substances are present in food, especially in plant materials. The salts of phytic acid, phospholipids and oxalates are the most common representatives of this group. Phosphoric, citric, tartaric, malic and ascorbic acids also possess pronounced chelating activities. Amino acids and peptides are typical metal chelating agents. The antioxidant activity of histidine-containing peptides is thought to be related to their metal-chelating ability, as well as to lipid-radical trapping potential of the imidazole ring (Pokorny *et al.,* 2001). According to Melgarejo *et al.* (2003) and Trad *et al.* (2012), figs contained citric, malic and oxalic acids.

4. Conclusion

The present study aimed to assess the varietal influence on the phytochemical contents and *in vitro* biological activities of light fresh edible figs grown Algeria. The results obtained showed significant variations for phenolic (217 to 342 mg/100 g) and flavonoid content (11.13 to 19.20 mg/100 g), as well as for nitric oxide scavenging activity (235.13 to 624.45 mg/100 g) and iron chelating power (24.19 to 62.58%). the results showed *Abearous*, *Elbakor* and *Taghanimte* varieties exhibited the best nitric oxide scavenging effect whereas *Tamriwthe* and *Taghanimte* varieties displayed the strongest iron chelating potential.

The present study can found a practical application when using the content of phenolic content as a biochemical biomarker to distinguish the fig varieties; however, it should be completed by the use of more numerous varieties and the determination of phenolic content with more accurate methods (liquid chromatography). This investigation proved that light skinned figs are natural store of bioactive antioxidants that are interesting because of their health benefits and preventive effects against many disorders, and can be considered as a functional food or at least as a functional food ingredient.

Acknowledgements

The authors are grateful to the Algerian Ministry of Higher Education and Scientific Research for the financial support.

References

[1] Bachir Bey M., Louaileche H. & Zemouri S. (2013). Optimization of phenolic compounds recovery and antioxidant activity of light and dark dried fig (*Ficus carica* L.) varieties. Food Science Biotechnology. 22: 1613-1619.

[2] Bachir bey M., Meziant L., Benchikh Y. & Louaileche H. (2014a). Deployment of response surface methodology to optimize recovery of dark fresh fig (*Ficus carica* L., var. Azenjar) total phenolic compounds and antioxidant activity. Food Chemistry. 162: 277–282.

[3] Bachir bey M., Meziant L., Benchikh Y. & Louaileche H. (2014b). Deployment of response surface methodology to optimize recovery of dried dark fig (*Ficus carica* L., var. Azenjar) total phenolic compounds and antioxidant activity. International Food Research Journal. 21 (4): 1477-1482.

[4] Benmeddour Z., Mehinagic E., Le Meurlay D. & Louaileche H. (2013). Phenolic composition and antioxidant capacities of ten Algerian date (*Phoenix dactylifera* L.) cultivars: a comparative study. Journal of Functional Foods. (5): 346-354.

[5] Caliskan O. & Polat A.A. (2011). Phytochemical and antioxidant properties of selected fig (*Ficus carica* L.) accessions from the eastern Mediterranean region of Turkey. Scientia Horticulturae. (128): 473–478.

[6] Carranza-Concha J., Benlloch M., Camacho M.M. & Martínez-Navarrete N. (2012). Effects of drying and pretreatment on the nutritional and functional quality of raisins. Food and Bioproducts Processing. (90): 243-248.

[7] Decker E.A. & Welch B. (1990). Role of ferritin as a lipid oxidation catalyst in muscle food. Journal of Agricultural Food Chemistry. (56): 674-677.

[8] Del Caro A. & Piga A. (2008). Polyphenol composition of peel and pulp of two Italian fresh fig fruits cultivars (*Ficus carica* L.). European Food Research and Technology. (226): 715-719.

[9] Djeridane A., Yousfi M., Nadjemi B., Boutassouna D., Stocker P. & Vidal N. (2006). Antioxidants activities of some Algerian medicinal plants extract containing phenolic compounds. Food Chemistry. (97): 654-660.

[10] FAO STAT. (2013). Statistics of the Food and Agriculture Organization. Web Site: www.faostat.org.

[11] Gorinstein S., Cvikrova M., Machackova I., Haruenkit R., Park Y.S., Jung S.J., Yamamoto K., Martinez Ayala A.L., Katrich E. & Trakhtenberg S. (2004). Characterization of antioxidant compounds in Jaffa sweeties and white grapefruits. Food Chemistry. (84): 503-510.

[12] Lim Y.Y., Lim T.T. & Tee J.J. (2007). Antioxidant properties of several tropical fruits: A comparative study. Food Chemistry. (103): 1003–1008.

[13] Marinova D., Ribarova F. & Atanassova M. (2005). Total phenolics and total flavonoids in Bulgarian fruits and vegetables. Journal of the University of Chemical Technology and Metallurgy. 40 (3): 255-260.

[14] Melgarejo P., Hernandez F., Martinez J.J., Sanchez J. & Salazar D.M. (2003). Organic acids and sugars from first and second crop fig juices. Acta Horticultura. (605): 237-239.

[15] Moncada S., Palmer R.M. & Higgs E. A. (1991). Nitric oxide: physiology, pathophysiology and pharrnacology. Pharmacological Reviews. (43): 109-142.

[16] Nakilcioglu E. & Hisil Y. (2013). Research on the phenolic compounds in sarilop (*Ficus carica* L.) fig variety. GIDA. 38 (5): 267-274.

[17] Pietta P., Gardana C. & Pietta A. (2003). Flavonoids in Herbs. Chapter 2 in: Rice-Evans C.A. & Packer L. Flavonoids in health and disease. 2nd Edition Marcel Dekker, Inc. Pp 43-69.

[18] Pokorny J., Yanishlieva N. & Gordon M. (2001). Antioxidants in food Practical applications. First published Woodhead Publishing Ltd and CRC Press LLC. 380 p.

[19] Russo F. (2014). Phenolic and aromatic characterization of fresh and dried figs of the "Dottato" Italian cultivar in comparison to Turkish and Greek figs varieties. Doctoral thesis, University of Naples "Federico II". 110 p.

[20] Shahidi F. & Naczk M. (2004). Phenolics in Food and Nutraceuticals. CRC Press: Boca Raton FL. 565 p.

[21] Singleton, V. L., & Rossi, J. A. (1965). Colorimetry of total phenolics with phosphomolybdic–phosphotungstic acid reagents. American Journal of Enology and Viticulture. 16, 144–158.

[22] Slatnar A., Klancar U., Stampar F. & Veberic R. (2011). Effect of drying of figs (*Ficus carica* L.) on the contents of sugars, organic acids, and phenolic compounds. Journal of Agricultural Food Chemistry. (59): 11696-11702.

[23] Solomon A., Golubowicz S., Yablowicz Z., Grossman S., Bergman M., Gottlieb H.E., Altman A., Kerem Z. & Flaishman M.A. (2006). Antioxidant activities and anthocyanin content of fresh fruits of common fig (*Ficus carica* L.). Journal of Agricultural Food Chemistry. (54): 7717-7723.

[24] Spanos GA. & Wrolstad RE. (1992). Phenolics of apple, pear, and white grape juices and their changes with processing and storage - a review. Journal of Agricultural and Food Chemistry. 40: 1478-1487.

[25] Trad M., Gaaliche B., Renard C.M.G.C. & Mars M. (2012). Quality performance of "Smyrna" type figs grown under Mediterranean conditions of Tunisia. Journal of Ornamental and Horticultural Plants. 2 (3): 139-146.

[26] Velioglu Y. S., Mazza G., Gao L. & Oomah B.D. (1998). Antioxidant activity and total phenolics in selected fruits, vegetables, and grain products. Journal of Agricultural Food Chemistry. (46): 4113-4117.

[27] Vinson J.A., Zubik L., Bose P., Samman N. & Proch J. (2005). Dried fruits: excellent *in vitro* and *in vivo* antioxidants. Journal of the American College of Nutrition. 24 (1): 44-50.

[28] Woodland, D.W. 1997. Contemporary Plant Systematics, 2nd edition. Andrews University Press, Berrien Springs, MI 610.