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ELLAGIC ACID: A REVIEW ON NATURAL SOURCES AND MEDICINAL IMPORTANCE

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ABSTRACT

Ellagic acid is a phenolic compound present in different plant species mainly in fruits and vegetables (and other plant parts such as leaves, root, bark, kernel) but also in processed foods (jams, alcoholic and non-alcoholic beverages) with a role in protecting the body against numerous conditions due to its antioxidant capacity. The amount of ellagic acid is different depending on the species, type of sample, temperature and extraction method, respectively method of analysis. This paper proposes an analysis of the specialized literature regarding the role and importance of ellagic acid for the human body, studied species with a high content of ellagic acid, the therapeutic medicinal importance and its potential as an antioxidant compound.

INTRODUCTION

It is well known that the nutritional properties attributed to fruits, herbs, seeds, processed foods and beverages are due to an important group of natural polyphenols classified as hydrolysable tannins called ellagitannins comprising one or more units of gallic acid and one or more units of hexahydroxydiphenoic acid (HHDP), ester-linked with a sugar residue (Alfei et al. 2019). Plant-based foods naturally contain polyphenols, compounds with a wide range of complex structures, and according to the strength of the phenolic ring, they can be classified into phenolic acids, flavonoids, stilbenes, phenolic alcohols and lignans (Abbas et al. 2017; Ahmad et al. 2021). Polyphenols are widely distributed in the plant kingdom and are important components of common foods, including tea, red wine, fruits, beverages, and various medicinal plants, and the role and importance of polyphenols stems come from their effects on sensory properties, including astringency and colour, and from health effects (Vekiari et al. 2008). Ellagitannins, important due to their chemical diversity and complexity, belong to the class of hydrolysable tannins which, by hydrolysis under acidic or alkaline conditions, can produce ellagic acid (Evtyugin et al. 2020). Considered antioxidants, they attract constant interest for various medical and pharmaceutical applications (antibacterial, antifungal, antiviral, anti-inflammatory, hepato and cardioprotective, chemopreventive, neuroprotective, antidiabetic, gastroprotective, antihyperlipidemic, antidepressant properties) (Evtyugin et al. 2020; Kilic et al. 2014). Interest in ellagic acid has increased in recent years due to its properties as a micronutrient, a hydrolytic product of ellagitannins that gives fruits and their products their characteristic taste and has an important role in food processing (Bakkalbaşi et al. 2008). New alternative sources of ellagic acid are constantly being investigated both in terms of content and its effect on combating or reducing certain ailments. According to Cannataro et al. (2021) ellagic acid, a dilactone of the gallic acid dimer, is a polyphenol present in some foods in a more complex form called ellagitannin, which is converted to ellagic acid by the body and is found predominantly in berries. Ellagitannins are hydrolysed into ellagic acid under *in vivo* physiological conditions, subsequently being metabolized by the intestinal microbiota to produce different types of urolithins (Landete 2011). Ellagitannins are phenolic compounds from the category of tannins, more precisely from the group of hydrolysable tannins (along with gallotannins) (Soong & Barlow 2006), phytoconstituents easily soluble in water at most pHs (Agrawal & Kulkarni 2020). Due to a wide range of biological effects of ellagic acid, edible plants containing this phytochemical compound and its hydrolysable derivatives, mainly ellagitannins, are a valuable source of ellagic acid for the human body and belong to functional foods that promote health and can reduce the risk of diseases (Sharifi-Rad et al. 2022). At the same time, ellagic acid has a role in preventing the infection of plants with various illnesses, as confirmed by Vekiari et al. (2008) who mention ellagic acid as having a role in plant protection against microbial and pest infections. Thus, different plant species are now being studied for their ellagic acid content in order to find and promote new sources in human nutrition, as well as sources of raw materials for the preparation of functional nutritional supplements and nutraceuticals.

Based on the mentioned characteristics, the role of ellagic acid for the human body and the need to know the potential sources of ellagic acid, the purpose of this paper was to identify from the specialized literature sources of ellagic acid, as well as a summary of medicinal and therapeutic importance.

CHEMICAL STRUCTURE OF ELLAGIC ACID

Ellagic acid has the molecular formula $C_{14}H_6O_8$, a molecular mass of 302.19 and a density of 1.667 at a temperature of approx. 17.8°C (PubChem). It belongs to the class of phenolic acids, the sub-class of hydroxybenzoic acids (along with gallic, protocatechuic, vanillic, salicylic acid) (Woodward et al. 2018), the family of dimeric hydroxybenzoic acids. Sharifi-Rad et al. (2022) refer to ellagic acid as hexahydroxydiphenic acid dilactone (HHDP), a dimeric gallic acid derivative, produced mainly by hydrolysis of ellagitannins, a widely distributed group of secondary metabolites. Ellagic acid has the properties of an amphiphilic molecule, from a structural point of view, it consists of a planar lipophilic biphenyl fragment linked to two lactone rings possessing four hydroxyl groups, which together with the lactone groups form a hydrophilic fragment (Tokutomi et al. 2018). According to Oszmiański et al. (2015) gallotannins are converted by plant biosynthesis to ellagitannins by oxidative coupling between two adjacent galloyl groups with hexahydroxydiphenoyl formation. The free radical scavenging activity of ellagic acid (Galano et al. 2014) refers to phenolic H atom transfer (HAT), single electron transfer followed by proton transfer (SET-PT) and sequential transfer mechanisms of electrons with proton loss (SPLET) (Evtyugin et al. 2020).

NATURAL SOURCES OF ELLAGIC ACID

Nowadays, due to the growing interest in bioactive chemical compounds from natural sources, which contribute both from a nutritional point of view and in protecting the body from various ailments, researchers are turning to lesser-known plant species. Due to technological progress and this interest in functional and natural foods and nutraceuticals, new methods of identification, extraction, analysis and quantification, followed by *in vivo* and *in vitro* clinical tests, demonstrate the beneficial role that some bioactive compounds have for human health. Among these phenolic compounds, frequently identified and studied by numerous researchers, is ellagic acid along with its derivatives (ellagitannins). The specialized literature provides sufficient information regarding the amount of ellagic acid contained in different plant organs (Table 1). Ellagic acid is a phenolic lactone compound found naturally in a variety of plant species, vegetables (Ríos et al. 2018), especially in fruits (Aguilera-Carbo et al. 2008; Koponen et al. 2007), in the form of hydrolysable tannins called ellagitannins as structural components of the plant cell wall and cell membrane (Vattem & Shetty 2005). Gupta et al. (2021b) mention ellagic acid as an important polyphenol in human nutrition and health present in fruits, vegetables, and various herbs. Ellagic acid, a natural phenolic constituent, is present as ellagitannins in grapes (Lee et al. 2005), strawberries (Hanhineva et al. 2008), black currant, raspberry, pomegranate, persimmons, peaches, plums (Derosa et al. 2016; Evtyugin et al. 2020; Larrosa et al. 2010). Oszmiański et al. (2015) confirm the presence of ellagic acid in wild blackberries from Poland. Also, in the study by Wang et al. (1995) ellagic acid was identified in the fruits of some species such as *Crataegus* spp., false strawberry (*Duchesnea indica*), strawberry (*Fragaria* spp.), blackcurrant (*Ribes nigrum*), blackberry, red raspberry, and cranberry (*Vaccinium macrocarpon*). Ríos et al. (2018) state that raspberry (*Rubus idaeus* L.) probably contains the highest concentration, with values ranging from 1900 mg/100 g FW (yellow raspberry) to 270 mg/100 g FW (wild raspberry), depending on the analysed sample. Stoenescu et al. (2022) identified ellagic acid in wild fruits, such as rosehips, hawthorn, cornelian cherry, wild pear, creamy strawberry (Table 1). Another source of ellagic acid are nuts. Landete (2011) mentions pecans (*Carya illinoinensis* [Wangenh.] K. Koch), walnuts (*Juglans regia* L.) (Cerdá et al. 2005) and almonds (Derosa et al. 2016; Xie et al. 2012) as natural sources of ellagic acid.

The amount of ellagic acid decreases with the ripening of the fruit, which has been shown by some researches. Williner et al. (2003) demonstrated that ellagic acid identified in strawberry cultivars is in the highest amount in non-coloured fruits and gradually decreases as they ripen. Olennikov et al. (2020) mention in the determinations carried out on the fruits of *Fragaria viridis* ellagitannins and ellagic acid as the predominant phenolic compounds in all the analysed stages of ripening of the fruits.

A variable amount of ellagic acid is also found in the leaves of many species, and numerous studies have demonstrated this. Raudonis et al. (2013) analysed ethanolic extracts from leaves and fruits of *F. viridis*, *F. vesca* and *F. moschata*, demonstrating the presence of ellagic acid and a much stronger antioxidant activity of leaves compared to that of fruits. Gudej and Tomczyk (2004) identified ellagic acid in leaves of cultivated and wild species of the genus *Rubus* (raspberry and blackberry) and Muthukumaran et al. (2017) in strawberry leaves in significant quantities ('Tribut' cultivar) results also consistent with the study by Maas et al. (1991). Also, Stoenescu et al. (2022) analysed and identified significant amounts of ellagic acid in the leaves of some wild fruit tree species such as European crab apple, hawthorn, creamy strawberry, blackthorn, cornelian cherry, blackberry (Table 1), higher values than those obtained in fruits in some of the mentioned species. Another source of ellagic acid is the bark of some species of interest, for example the stem bark and bark of *Eucalyptus globulus*, *Eucalyptus maculate* (Girish & Pradhan 2008; Kim et al. 2001), chestnut bark (Vekiari et al. 2008), *Dipentodon sinicus* bark (Ye et al. 2007), *Anisophyllea dichostyla* root bark (Khallouki et al. 2007). The flowers of certain species are also potential sources of ellagic acid, and research in this direction provides sufficient information. For example, pomegranate flowers according to Wu et al. (2021) and Li et al. (2019), dog rose, creamy strawberry, blackberry, elder, blackthorn flowers (Stoenescu et al. 2022), *Woodfordia fruticosa* flowers (Syed & Khan 2016) contain variable amounts of ellagic acid.

In addition to the presence of ellagic acid in fruits, vegetables, medicinal plants, this phenolic compound can also be formed due to processing in various forms (Gupta et al. 2021b) such as jams (Zafrilla et al. 2001; Wojdyło et al. 2008; Amakura et al. 2000), tea (Yang & Tomás-Barberán 2018), juices (Seeram et al. 2004), wines (Talcott & Lee 2002), whiskey (Fujieda et al. 2008) and cognac although in relatively smaller amounts. According to Goldberg et al. (1999) ellagic acid along with gallic acid are among the main phenolic compounds present in aged distilled alcoholic beverages such as cognac and brandy. Honey, according to Kassim et al. (2010), is also a good source of ellagic acid, with values between 626.74-3295.83 µg/100g DW in the study performed on Malaysian honey.

Some fungi can also be potential sources of ellagic acid as mentioned by Ribeiro et al. (2007) in their study on beefsteak fungus (*Fistulina hepatica*) which according to the performed analysis is one of the main compounds found in this species. Vegetables, spices and herbs are another source of ellagic acid. Galani et al. (2017) concluded the presence in high amounts of ellagic acid in dill leaves (12,231.48 mg/100g FW), onion leaves (3655.16 mg/100g FW), fenugreek leaves (681.97 mg/100g FW), spinach leaves (323.05 mg/100g FW), cabbage (630.94 mg/100g FW), green pepper (7.31 mg/100g FW), cauliflower (611.03 mg/100g FW), tomato (51.84 mg/100g FW), potato (46.28 mg/100g FW), and sugar beet (274.08 mg/100g FW). The same authors mention that after 15 days of storage at 4°C, the content in ellagic acid increases in most of the analysed species. The compound was also identified in carrot (53.32 mg/100g FW) but only after storage according to the same study.

The temperature and duration of storage of fruits, vegetables, processed foods can influence to some extent the amount of ellagic acid. According to Sharifi-Rad et al. (2022) it was shown that the storage and freezing of fruits, as well as their processing for the production of beverages and jams, can influence the content of ellagic acid.

Table 1

The ellagic acid content of some plant parts according to the specialized literature

Species	Plant part	Amount	Reference	Species	Plant part	Amount	Reference
Banans	Fruits	0.02 mg g^{-1} DW	Williner et al. (2003)	*Castanea sativa* Mill.	Bark Fruits	0.71-21.6 mg g^{-1} DW 0.03-5.98 mg g^{-1} DW	Vekiari et al. (2008)
Plums		0.07 mg g^{-1} DW		*Rosa moyesii*	Fruits	68.29 µg g^{-1} DW	Karczmarz et al. (2019)
Fragaria × *ananassa*		0.50 mg g^{-1} DW		*R. canina* L.	Fruits	36.71 µg g^{-1} DW	
Green apples		0.07 mg g^{-1} DW		*R. penduline* L.	Fruits	247.72 µg g^{-1} DW	
Pears		0.04 mg g^{-1} DW		*R. sweginzowii* Koehne	Fruits	20.244–29.771 mg 100g^{-1} DW	Szmagara et al. (2023)
Pineapple		0.06 mg g^{-1} DW		*Fragaria viridis* (L.) Weston	Fruits	0.10-0.12 mg g^{-1} FW	Olennikov et al. (2020)
Clementines		0.04 mg g^{-1} DW		*Pyrus pyraster* (L.) Burgsd.	Fruits Leaves	4.78 mg 100g^{-1} DW 3.79 mg 100g^{-1} DW	Stoenescu et al. (2022)
Fragaria × *ananassa* 'Tribut'	Leaves	807 mg 100g^{-1} FW	Muthukumaran et al. (2017)	*Rosa canina* L.	Fruits Leaves Flowers	9.14 mg 100g^{-1} DW 293.39 mg 100g^{-1} DW 278.17 mg 100g^{-1} DW	
	Fruits	12.3 mg 100g^{-1} FW		*Crataegus pentagyna* Waldst. et Kit.	Fruits Leaves	33.56 mg 100g^{-1} DW 85.93 mg 100g^{-1} DW	
Fragaria vesca L.	Leaves and stem	69.5 mg g^{-1} DW	Dias et al. (2015)	*Crataegus monogyna* (L) Jacq.	Fruits Leaves	107.76 mg 100g^{-1} DW 8.58 mg 100g^{-1} DW	
Rubus idaeus L.	Fruits	1900 mg 100g^{-1} FW	Ríos et al. (2018)	*Fragaria viridis* (L.) Weston	Fruits Leaves	351.96 mg 100g^{-1} DW	

					Flowers	549.58 mg $100g^{-1}$ DW 8.61 mg $100g^{-1}$ DW	
	Fruits	270 mg $100g^{-1}$ FW		*Cornus mas* L.	Fruits Leaves	175.15 mg $100g^{-1}$ DW 47.38 mg $100g^{-1}$ DW	
Rubus idaeus L.	Fruits	263.7 mg $100g^{-1}$ FW	Koponen et al. (2007)	*Malus sylvestris* (L.) Mill.	Leaves	2537.69 mg $100g^{-1}$ DW	
Rubus chamaemorus L.	Fruits	315.1 mg $100g^{-1}$ FW		*Rubus caesius* L.	Leaves	91.21 mg $100g^{-1}$ DW	
Rosa canina L.	Fruits	109.6 mg $100g^{-1}$ FW		*Rubus fruticosus* L.	Leaves Flowers	43.68 mg $100g^{-1}$ DW 9.61 mg $100g^{-1}$ DW	
Hippophae rhamnoides L.	Fruits	1 mg $100g^{-1}$ FW		*Prunus spinosa* L.	Leaves	16.25 mg $100g^{-1}$ DW	
Fragaria × *ananassa*	Fruits	68.3–79.9 mg $100g^{-1}$ FW		*Sambucus nigra* L.	Flowers	26.90 mg $100g^{-1}$ DW	
Rubus idaeus L.	Fruits	1692–1794 mg $100g^{-1}$ FW	Kähkönen et al. (2001)	*Prunus spinosa* L.	Leaves and flowers	1547.8 mg kg^{-1} DW	Temiz & Okumuz (2022)
Rubus chamaemorus L.	Fruits	1090-1423 mg $100g^{-1}$ FW		*Ziziphus jujuba* Mill.	Fruits	7.8 µg $100g^{-1}$ FW	Wu et al. (2012)
Fragaria × *ananassa*	Fruits	81-184 mg $100g^{-1}$ FW		*Rubus idaeus* L.	Fruits	28.6 mg $100g^{-1}$ FW	Mihailović et al. (2019)
Rubus sp.	Fruits	150 mg $100g^{-1}$ FW	Daniel et al. (1989)	*Fragaria* × *ananassa*	Fruits	0.263–0.617 mg $100g^{-1}$ FW	Davik et al. (2020)
Cranberry	Fruits	12 mg $100g^{-1}$ FW		*Castanea* sp.	Processed kernel Unprocessed kernel	20–70 mg $100g^{-1}$ DW 10–50 mg $100g^{-1}$ DW	Donno et al. (2023)
Rubus idaeus L.	Fruits	150 mg $100g^{-1}$ FW		*Myrciaria jaboticaba* (Vell.) Berg	Fruits	0.215-3.11 g kg^{-1} FW	Abe et al. (2012)
Fragaria × *ananassa*	Fruits	63 mg $100g^{-1}$ FW		Blackberry	Fruits	37.60 mg $100g^{-1}$ FW	Komorsky-Lovrić & Novak (2011)

Carya illinoinensis	Kernel	33 mg $100g^{-1}$ FW		Raspberry	Fruits	40.06 mg $100g^{-1}$ FW	
Juglans sp.	Kernel	59 mg $100g^{-1}$ FW		Strawberry	Fruits	5.52 mg $100g^{-1}$ FW	
Carya illinoinensis (Wangenh) C. Koch	Kernel	20.96-86.2 g kg^{-1} DW	Malik et al. (2009)	*Rubus* sp.	Fruits	11 mg g^{-1} DW	Bakkalbaşi et al. (2008)
Castanea sp.	Kernel	1.61-24.9 mg kg^{-1} DW	Gonçalves et al. (2010)	*Fragaria vesca* L.	Fruits	122.5 µg g^{-1} FW	Milivojević et al. (2011)
Rubus arcticus L.	Fruits	0.7-3.2 mg g^{-1} DW	Törrönen (2009)	*Rubus idaeus* L.	Fruits	12.71 µg g^{-1} FW	
Grapes	Fruits	0.36–0.91 mg g^{-1} DW		*R. fruticosus* L.	Fruits	61.7 µg g^{-1} FW	
Rubus sp.	Fruits	0.015-0.022 mg g^{-1} DW	Clifford & Scalbert (2000)	*Vaccinium corymbosum*	Fruits	1.65-9.16 mg kg^{-1} DW	Seyhan et al. (2023)

THE MEDICINAL AND THERAPEUTIC IMPORTANCE OF ELLAGIC ACID

The role of ellagic acid from a medicinal, therapeutic, curative point of view has been intensively researched and investigated according to data from the specialized literature. The importance of bioactive compounds as functional food supplements has been and is constantly explored due to their effectiveness in improving health through the prophylaxis or treatment of various ailments (Tošović & Bren 2020). Bioactive compounds are phytochemicals involved in the protection of human health against chronic degenerative diseases and depend on their bioavailability to express their biological properties, and the extent and speed of their absorption in the intestines is decided by their chemical structure (Abbas et al. 2017). Products rich in ellagic tannins are first hydrolysed to ellagic acid in the stomach and small intestine, and then converted to urolithins with high bioavailability to the intestinal flora (Zhang et al. 2022). Ellagic acid, a plant polyphenol is structurally a condensed dimer of gallic acid and is found either in combined form with hexahydroxydiphenic acid or in bound form (ellagitannins) and exhibits biological, antioxidant, antidiabetic, anticancer and apoptosis-inducing properties, which gives it a therapeutic potential in the treatment of numerous conditions, especially cancer (Shakeri et al. 2018). The antioxidant properties of ellagic acid are due to its free radical scavenging activity (Ratnam et al. 2006).

Ellagic acid has been shown to be a potent anticancer and antimutagenic compound involved in preventing the activation of environmental toxins, mutagens, and carcinogens (Zhang et al. 1993; Khanduja et al. 1999; Usta et al. 2013). Ellagic acid is an experimental drug being studied for the treatment of follicular lymphoma, protection against brain damage in infants with intrauterine growth restriction, and improvement of cardiovascular function in overweight teenagers (PubChem). The therapeutic action of ellagic acid mainly involves antioxidant and anti-proliferative effects. Degotte et al. (2023) mention ellagic acid as a good candidate in the treatment of malaria due to its strong antiplasmodial effect both *in vivo* and *in vitro*.

According to some studies, the amount of vitamin C can have an influence on the amount of ellagic acid present in different samples. Williams et al. (2014) mention the importance of vitamin C in the protection of phenolic compounds, respectively in the conducted study it demonstrates the fact that a large amount of vitamin C also means a large amount of ellagic acid (study conducted on fruits of *Fragaria × ananassa* cv. 'Camarosa', *Rubus ursinus × idaeus* and *Terminalia ferdinandiana*).

Numerous researches demonstrate the beneficial role of ellagic acid on the protection of certain organs such as the heart, liver and kidneys. Ellagic acid possesses antioxidant, antihepatotoxic, antisteatotic, anticholestatic, antifibrogenic, antihepatocarcinogenic and antiviral properties that improve liver architecture and functions against toxic and pathological conditions (Sharifi-Rad et al. 2022). According to Battisti et al. (2023) liver pyruvate kinase (PKL) recently emerged as a new target for non-alcoholic fatty liver disease (NAFLD), mention ellagic acid and its derivatives as potential inhibitors of this enzyme. The results obtained by Gupta et al. (2021a) showed that ellagic acid and *Terminalia bellirica* fruit extracts have the potential to alleviate oxidative stress and hepatotoxicity produced by long-term use of diclofenac on the liver. At the same time, numerous researchers have confirmed the role of ellagic acid in protecting the liver against numerous diseases (García-Niño & Zazueta 2015; Yüce et al. 2007; Aishwarya et al. 2021).

Derosa et al. (2016) mention ellagic acid as a beneficial compound in the treatment of liver disorders, gastroenterological, neurological diseases, and Ahmed et al. (2016) also adds that it is beneficial in treating depression and anxiety. Also, in terms of protecting the kidneys as a result of the aging process, Naghibi et al. (2023) state the beneficial role and importance of ellagic acid on it.

Regarding cardiovascular diseases, Jordão et al. (2017), Larossa et al. (2010), Salinger-Martinovic et al. (2021) are some of the researchers who mention and demonstrate the role of ellagic acid on various heart diseases.

The role of ellagic acid on prostate disorders has also been intensively studied (Bell & Hawthorne 2008; Malik et al. 2011; Vanella et al. 2013; Wang et al. 2014; Pitchakarn et al. 2013). Naiki-Ito et al. (2015) mention the use of pomegranate juice and implicitly the ellagic acid contained, as having a role in decreasing the incidence of adenocarcinoma in the lateral prostate, and in suppressing the progression of prostate carcinogenesis.

According to the literature, ellagic acid may have an important role in the treatment of diabetes (Amor et al. 2020; Farbood et al. 2019; Maleki et al. 2023). Type 2 diabetes, a disease with an alarming rate of growth, and an estimated 463 million people worldwide today, is thought to have an incidence rate of 700 million by 2045 (Chatterjee et al. 2017). Due to its antioxidant and anti-inflammatory properties, ellagic acid has the potential according to the study by Maleki et al. (2023) to remedy the metabolic effects of chronic noncommunicable diseases by improving glycemic indicators, dyslipidaemia, oxidative stress, and inflammation in diabetes. Ellagic acid at concentrations of 10-50 mmol/L stimulates apoptosis of pancreatic adenocarcinoma cells according to the study by Edderkaoui et al. (2008). Since oxidative stress causes multiple DNA damages, inducing mutations in proto-oncogenes and tumour suppressor genes, ellagic acid could be a potential agent to promote the antioxidant response and thereby overcome the process of carcinogenesis (Sharifi-Rad et al. 2022). Yousuf et al. (2020) mention ellagic acid as an inhibitory compound of cancer cells (CDK6) involved in breast cancer (also confirmed by Golmohammadi et al. 2023), while Bisen et al. (2012) brings to the knowledge its role in oral cancer, and Duan et al. (2020) in mitochondrial respiration and lung cancer. Yang and Tomás-Barberán (2018) mention in their study that the ellagic acid present in different teas is absorbed by the human body in different concentrations, and eliminated through the urine in the form of urolithin. Ellagic acid has been extensively investigated due to its antiproliferative action in some types of cancers, together with its anti-inflammatory effects, and a growing number of studies suggest that ellagic acid intake is effective in alleviating obesity and ameliorating obesity-mediated metabolic complications such as resistance to insulin, type 2 diabetes, non-alcoholic fatty liver disease, and atherosclerosis (Kang et al. 2016).

Ellagic acid extracted from new, more natural sources can represent a substitute for current supplements, from the point of view of costs (pomegranate requires certain climatic conditions for growth and development) and from the point of view of regions that abound in such new sources with a preponderance in disadvantaged areas.

CONCLUSIONS

According to specialized literature, ellagic acid is a phenolic compound with therapeutic, curative, medicinal properties, used in the treatment of numerous ailments. The antioxidant capacity it possesses includes it in the category of bioactive compounds of interest to researchers. The role and importance of ellagic acid and its derivatives have long been investigated, but new research into its effects on the body is currently being developed. The sources of ellagic acid are diverse and further investigation is needed to explore new species of interest that may provide data on the amount of ellagic acid contained and subsequently how to apply it in different concentrations and in different forms as nutraceuticals or functional foods to protect the human body.

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