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Chemical composition and great applications to the fruit of the pomegranate (*Punica granatum*): a review

Jesús Alberto CORONADO-REYES[1]; Consuelo de Jesús CORTÉS-PENAGOS[2], Juan Carlos GONZÁLEZ-HERNÁNDEZ[1]*

Abstract

The pomegranate (*Punica granatum*) belong the *Punicaceas* family and is a plant of Iran that is characterized by the fruit that it give because is a big globular berry that inside have a lot of seeds wrapped in a juicy edible pulp covered for a gross peel with green, yellow and red tonalities depending of the ripening state and the varieties. The harvest and consumption of the fruit has gone increasing in Mexico due of the actual findings of phytochemical compounds whit antioxidant, anti-inflammatory and antiviral activity with application in products of food industry and pharmaceutical and it has even been observed microbicide activity versus fungus responsible of crop rot and pathogenic bacteria, nevertheless, in the treatment of the fruit the peel isn´t used and is discarded, so, in this project we want to describe on general way the fruit and the alternatives that has been worked actually in the exploration and application of phytochemical compounds like the polyphenols in whole the plant.

Keywords: pomegranate; polyphenols; antioxidant; microbicide.

Practical Application: With the analysis of the chemical compounds that the pomegranate tree has in each of its parts, it is important to know which of them can be extracted, purified and applied to different biotechnological products, since they can be substituted from those currently used to from other fruits or even from others artificially created.

1 Introduction

Pomegranate (*Punica granatum*) is a tree belonging to the *Punicaceae* family with a height around 3 to 6 m (García-Viguera & Pérez, 2004) and is a native product of Iran (Sarkhosh et al., 2006) that recently adapts to climates Mediterranean type, generating an extremely juicy fruit. The leaves are bright green, elongated, smooth and shiny, slightly wavy. The flora is flared and is often made up of 5 to 8 bright orange petals (Morton, 1987), tending to appear (flowering) in the month of May and July (García-Viguera & Pérez, 2004). Pomegranate fruit arises from the growth of the lower ovary after the fertilization of the flora (López & Palou, 2010), which is characterized by a globose berry with a balausta label, bright red, yellowish or whitish green, crowned by a calyx 3 to 8 cm in diameter, full of seeds and leathery peel. The seeds with thick, of woody consistency and fleshy or pulpy testa, in a prismatic way, very juicy with colours ranging from intense ruby to white and sweet and sour taste (García-Viguera & Pérez, 2004).

1.1 Culture

Pomegranate is a tree whit growing adaptable to tropical or temperate climates, however, its commercial level cultivation has been limited to regions with tropical and subtropical climates (Chandra et al., 2010) consuming fresh or processing the fruit in juices, jams, syrups and sauces (Tehranifar et al., 2010).

The production of the product in Iran, country of origin, covers an area of 56, 329 hectares with an annual production of 705,166 tons (Mohseni, 2009), however, the main producer of a worldwide level is India with a sown area of 100,000 hectares commercialized in fresh since the variety grown in that country is characterized by having a large amount of pulp around the seed and even for this reason it is called as "pomegranate without seed", these varieties are identified with the name of Bedana variety and Kandhari (López & Palou, 2010). As for the east, the varieties that are mostly cultivated are Ahmar, Aswad. Halwa, Mangulati, Wonderful, Red Loufani, Malassi and Ras Baghl. What respects the European Union, Spain is the main producer, cultivating around 2,325 hectares with an approximate production of 27,389 tons, concentrating in the municipality of Alicante, which corresponds to 88% of the cultivated area and 92% of production. Intensive, specialized cultivation, as well as competition, has allowed 90% of production to be exported in that country.

In America, California (United States) is the main producer where Ruby and sweet varieties were initially grown. Fruits however for the 20th century. These varieties were replaced by the cultivation of the Wonderful variety until today. What respects South America the countries with greater production in Argentina and Chile In Mexico, until 1990, production was concentrated in the state of Puebla, sowing only in that last year an area of 5 hectares that contributed nationwide 30 tons of the fruit, this in only 11 municipalities of the entity. However, currently its production and consumption has been boosted due to the important findings regarding phytochemical compounds in the product

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[1]*Tecnológico Nacional de México / Instituto Tecnológico de Morelia, Morelia, Michoacán. México*
[2]*Facultad de Químico Farmacobiología, Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Michoacán, México*
*Corresponding author: juan.gh@morelia.tecnm.mx

with various applications in the food and pharmaceutical sector and where one of the main driving institutions is the Instituto Nacional de Invetigaciones Forestales, Agrícolas y Pecuarias (INAFAP) counting until 2017 with the following production at the national level consulted in the Servicio de Información Agroalimentaria y Pesquera (SIAP). In the Table 1 show the production in 2017.

1.2 Chemical composition in edible fraction

The composition of the pomegranate varies in relation to the type of cultivation, region of growth, climate, maturity and cultural practices (Heshi et al., 2001), observing that the organoleptic characteristics and the benefits offered by its consumption are due to the presence of compounds polyphenolics such as the anthocyanins responsible for the reddish colour, as well as the tannins to which their astringent taste is due to being organic acids, citric and malic acid, responsible for the acidified taste, while ellagitannins and to a lesser extent anthocyanins confer properties as antioxidants (García-Viguera & Pérez, 2004).

The pomegranate of the Wonderful variety is the most consumed in the American continent because it is the one that has adapted the easiest in the territory and then Table 2 is presented with the proximal analysis of the composition of the fruit in the edible part it contemplates the grains that contain the peel.

As it can be observed, the fruit is constituted to a greater extent by water and sugars, the content of lipids and proteins being lower giving it a low caloric power ideal for consumption, on the other hand it can be observed that it is an important source of water, potassium and vitamins where, due to its high content of water and potassium, as well as the low concentration of sodium, they give it diuretic and purifying properties, which, together with its concentration in citric acid, favors the elimination of uric acid and its salts through the urine, so its consumption is very adequate in case of suffering from gout, renal lithiasis due to uric acid salts, obesity or hypertension.

For a better understanding and analysis of the compounds present in the pomegranate, the chemical composition in each of the constituent parts of the tree is shown below.

1.3 Composition chemical in the whole fruit

1.3.1 Seed

The seed contain oil whose weight corresponds to 12 to 20% of the weight of the seed of which 80% of the oils correspond to octadecatrienoic fatty acids (Hornung et al., 2002). Within the content of fatty acids, 99% corresponds to triacylglycerols and to a lesser extent there is the presence of lignins and hydroxycinnamic acids (Wang et al., 2004). As conjugated fatty acids, there is a punic acid, and in the unconjugated there is linoleic, oleic, palmitic and stearic acid. In addition to these compounds, the presence of tocopherols (γ-Tocopherols), ursolic acid, sterols (daucosterol, camesterol, stigmasterol, β-sitosterol and cholesterol), sex sterodides (17-α-estradiol, estrone, testosterone and estriol) has been reported. and hydroxybenzoic acids such as gallic acid and ellagic acid.

Table 1. Mexican pomegranate (*Punica granatum*) production in 2017 year (Taken and modified of SIAP).

	State	Surface (ha)		Production (ton)	Production value (Thousand pesos)
		Seeded	Harvested		
1	Aguascalientes	3	0	0	0
2	Baja California	16	11	53	342.7
3	Chihuahua	40	0	0	0
4	Coahuila	27	25	106.25	2,138.28
5	Colima	5	4	30.8	168.29
6	Durango	21.9	20.9	155.71	1,712.81
7	Guanajuato	73	70	1,069.47	7,697.59
8	Hidalgo	139.5	126.5	1,211.82	5,953.69
9	Jalisco	79.5	66.5	396.28	4,602.53
10	México	42	42	332.5	1,690.67
11	Michoacán	6	6	47.4	538.05
12	Morelos	260	260	1.473.4	12,679.02
13	Oaxaca	202	186	1,284.68	14,212.16
14	Puebla	79	69	195.5	1,620.27
15	Querétaro	4	3	10.65	47.93
16	San Luis Potosí	9	9	62.1	487.74
17	Sonora	70	40	355.8	3,599.13
18	Zacatecas	8	8	30.86	144.92

Table 2. Edible fraction composition of *Punica granatum* fruit (Taken and modified of García-Viguera & Pérez, 2004).

Constituyente	Concentration
Water (g)	82.5
Food fiber (g)	3.1
Protein (g)	0.7
Lípids (g)	0.6
Carbohydrates (g)	16.7
Glucose*	7.2
Fructose*	7.9
Sacarose*	1.0
Minerals (mg)	
Sodium*	7.0
Potassium*	290.0
Calcium*	8.0
Magnesium*	3.0
Fosforus*	17.0
Iron*	0.5
Vitamins (mg)	
Thiamine (B1 vitamin)*	0.05
Riboflavin (B2 vitamin)*	0.02
Ascorbic acide (vitamina C)*	7.0
Nicotinamide (niocin)*	0.3
Organics acides (g)	0.77
Malic acide*	0.1
Citric acide*	0.5

*Composition per 100 g of edible contenid.

1.3.2 Juice

The characteristic colour of pomegranate juice is due to the presence of anthocyanins and flavonoids which are compounds with antioxidant activity that increase the intensity of colour depending on the ripening state of the fruit (Hernández *et al.*, 1999). Other compounds with significant presence in the juice are hydroxycinnamic acids (caffeic acid, chlorogenic acid, p-cumaric acid), catechins (Qian et al., 2005), proanthocyanidins, quercetin and elagitannins such as punicalin and punicalagina (Adams et al., 2006). As for the sugars present, there is glucose, fructose and sucrose, aliphatic organic acids such as citric acid, malic acid, tartaric acid, fumaric acid and succinic acid (Poyrazoglu et al., 2002). The mineral contribution of this fraction is characterized by the presence of iron, manganese, magnesium, calcium, sodium, strontium, potassium and zinc (Lansky & Newman, 2007).

1.3.3 Peel

Among the main components reported in the peel, flavonoids of which flavonoles (kemferol and quercetin), glycosylated flavonoles (rutin, kemferol-3-O-glycoside), flavones (luteolin) and flavones can be mentioned glycosylated (naringin), anthocyanins (delfinidine, cyanidine, pelargonidine, as well as their glycosylated forms) being the latter responsible for the colorings of the fruit (Hernández et al., 1999). As for elagitannins, punicalagina and punicalin have also been identified (Vidal et al., 2003) being specific for pomegranate, as well as the presence of corilagina, casuarinine, pedunculagina, telimagrandin, granatin A and B, punicafoline (Tanaka et al., 1986). Other polyphenolic compounds present are hydroxybenzoic acids (gallic acid and ellagic acid), hydroxycinnamic acids (caffeic acid, chlorogenic acid, p-cumaric acid), catechins and epicatechin (de Pascual-Teresa et al., 2000).

1.3.4 Leaves

As in the peel, tannins are found in the leaves, as well as some glycosides such as apigenin which is a flavone with uses such as anxiolytic (Zand et al., 2000) and naringin which has been studied for its effects as an anticancer. Other polyphenols present are glycosylated flavones (luteolines), punicalinas, punicalaginas, corilagina and punicafolina (Nawwar et al., 1994). As for the mineral content this varies depending on the growth stage of the leaf since in the middle stage the nitrogen concentrations are higher, in the young stage the element that is most abundant is potassium and in the mature and old leaves the Abundance is calcium and iron. Something that is important to mention is that during the ripening of the fruits the concentrations of magnesium, iron and zinc decrease significantly (Munde et al., 1980).

1.3.5 Flowers

Gallic acid is one of the compounds contained in this part of the plant as well as in the peel, another acid present is ursolic acid which is also and which is characteristic of this plant (Huang et al., 2005). The presence of terpenic compounds in flowers is significant compared to the other fractions of the plant, identifying triterpenoids such as maslinic acid (Márquez Martín et al., 2006), Asian acid (Sadhu et al., 2006) in lower concentrations with activity anticancer, and oleanolic acid.

1.3.6 Root and Peel

The alkaloids are the compounds with a majority presence mentioning the alkaloids of pelletierine, piperidine (Sedridine), pyrolidine (norigrin). In lower concentrations are elagitanics such as punicacortein A, B, C and D (Tanaka et al., 1986).

As can be seen, the polyphenolic compounds have a particular majority presence in the fruit and have gained importance due to the properties that their consumption confers and whose concentration is approximate to 83 mg / 100 g of edible portion or 250 mg / 100 ml whose presence It is older than other plants such as green tea. Within the polyphenols, the anthocyanins are those that are in the highest concentrations responsible for the characteristic colourings of the fruit, as already mentioned, and where 6 have been identified that are characteristic of the pomegranate which are: 3-glycosides and 3,5 diglycosides of delfinidine, cyanidine and pelargonidine where cyanidine derivatives are found in a proportion above 60%. The colour granted by this type of flavonoids varies with the molecular structure, since if hydroxylation increases, the bluish color increases. The form responsible for the red coloration is that of the flavilium cation, although depending on the pH or temperature they can move

towards the other forms with which it is kept in balance, and which are colourless (pseudobase carbinol and chacona) or bluish (quinoidal base), generally producing undesirable alterations. Thus, the flavilium cation form predominates at low pH (<3) and temperature of 20 ° C, shifting the equilibrium towards the other forms as we increase these two factors. In addition to these compounds, there are other elements that influence the stability of these pigments, such as ascorbic acid, sugars, the presence of co-pigments, enzymes, etc. (García-Viguera & Pérez, 2004).

The second major compounds are elagitannins, derivatives of ellagic acid and other hydrolysable tannins within which the most important are punicalagins having a concentration of 156 mg/100 ml of juice and found abundantly in the crust. Punicalagina is an elagitannin in which the gallic and ellagic acids bind to a glucose molecule, the isomers thereof being responsible for the yellowing of the peel. Pomegranate peel is a more important source of punicalagins and ellagic acid than aryls where the punicalagine content of the crust ranged from 114.6 to 282 mg / g dry weight, while the ellagic acid content varied from 1.07 to 2.49 mg/g dry weight (García-Viguera & Pérez, 2004).

On the other hand, in the bark of the fruit and the internal peels that separate the grains are rich in alkaloids, mainly peleterin, which give them medicine properties. Likewise, the punicorteins of the cortex give antitumor effects to its preparations (García-Viguera & Pérez, 2004).

1.4 Antioxidant activity

Free radicals are atoms or groups of atoms that have a missing electron, so they are very reactive, since they tend to pick up an electron from other atoms in order to achieve their electrochemical stability. Once the free radical has managed to subtract the electron (reduction) it needs, the stable molecule that loses it (oxidation) becomes a free radical because it has a missing electron, thus initiating a chain reaction (Maldonado et al., 2010). The attack of free radicals affects the biomolecular of the organism since they are the result of the metabolism causing oxidative stress which, if it becomes persistent, can cause diseases such as diabetes or even cancer, so they take care of molecules that can stabilize them To avoid damage, these molecules are called "antioxidants" which can be enzymatic or non-enzymatic and where some products resulting from secondary plant metabolism, such as polyphenolic compounds, enter the antioxidants of the second group.

An antioxidant is a compound that, when added to a food product, delays the process of lipid peroxidation or the oxidation of some other biomolecule and although there are synthetic antioxidants such as butylated hydroxyanisole (BHA) it has restricted use since they can have adverse effects on the health (Singh et al., 2002) so today there is a need to extract and apply antioxidant compounds of natural origin so that the compounds present in the pomegranate can meet this demand since it has been reported that the activity of flavonoids as antioxidants depend on the redox properties of their hydroxyphenolic groups and the structural relationship between different parts of the chemical structure. This basic structure which consists of a common skeleton of diphenylpyranos (C6-C3-C6), composed of two rings of phenyls (A and B) linked through a C-ring of pyran (heterocyclic) allows a multitude of substitution patterns and variations in the C ring. Flavonoids remove reactive oxygen especially in the form of superoxides, hydroxyl radicals, lipid peroxides or hydroperoxides, thus blocking the deleterious action of these substances on cells (Rahman, 2007) or molecules of the foods.

In 2002 Singht *et al*., carried out extractions of the rich fraction of compounds with antioxidant activity of the husk and seed of *Punica granatum* using solvents for extraction such as ethyl acetate, methanol and water by maceration by stirring with a stirrer magnetic. The evaluation was in vitro models using the method of â-carotene-linoleate and 1,1-diphenyl-2-picryl hydrazyl acid (DPPH) where methanol was the best extractant solvent reaching a percentage of 81% inhibition in the peel and 23.2% in seed with the DPPH method verifying that the greatest activity as an antioxidant is in the compounds present in the peel. To reinforce the above, tests were carried out to inhibit thiobarbituric acid, hydroxyl radical and oxidation of LDL (low density lipoproteins), having a percentage of 56%, 58% and 93.7% respectively, even compound characterizations were made phenolic in HPLC and the highest number of peaks in the chromatogram occurred in the extracts with methanol as a solvent, confirming the usefulness of this fruit for this purpose. On the other hand, it is reported in a work of 2003 the grenade peel contains compounds with antioxidant activity if extractions are made by maceration for one hour using as ethyl solvents, acetone, methanol and water at room temperature where the extracts with methanol were the ones that had the highest activity as an antioxidant, the yields obtained from extraction were 9.4% for methanol and 1.04% for ethanol, where the total phenolic content was 170 mg / g dry peel for ethanol, 400 mg / g dry peel for acetone, 460 mg / g dry peel for methanol and 140 mg / g dry peel for water observing that methanol is an ideal solvent as a carrier of phenolic compounds with antioxidant activity since when testing with DPPH These extracts had the greatest inhibition (Negi & Jayaprakasha, 2003).

Extracts of the whole pomegranate fruit have a positive effect for the reduction of hydrogen peroxide-induced damage which has been proven in in vitro models using Chinese Hamster ovarian cell cultures in the work done in 2008 where with the cytofluorimetric method it was possible to measure the level of oxidation caused by the reactive species, observing that in the experimental runs that there was the presence of pomegranate compounds a reduction in the oxidation of dichlorodihydrofluorescein diacetate (DCFH) was observed at dichlorofluorescein (DCF) that is highly fluorescent so this fluorescence is significantly diminished, this is attributed specifically in the work to the presence of ellagic acid since they are made comparative with the work done by Cozzi *et al.,* where it was used this phenolic compound to test the DCFH method and the results were very close, po r which is hypothesized that the power as an antioxidant is due to the presence of this acid (Sánchez et al., 2008). Recently, Arbayza et al. (2014), Evaluated the ratio of the content of total polyphenols in juice, aqueous extracts by decoction and infusion and finally in hydroalcoholic

extracts using ethanol as a solvent by means of peel reflux by measuring the% inhibition of DPPH radical obtaining 25.6%, 59.7%, 43.2% and 84.4% respectively, the concentration of total phenols was also measured by Folin-Ciocalteu method in tannic acid equivalents (mg/ml) obtaining a concentration of 0.0061 mg/ml for the juice, 0.0057 mg/ml in extracts with ethanol, 0.0051 mg/ml by decoction and 0.0047 mg/ml by infusion observing that the highest concentration of phenols is found in the fruit juice and the greatest antioxidant activity against the radical it is in the peel compounds, and although in this work no correlation was found between the two measurable response variables if significant presence of poly compounds is indicated phenolic.

1.5 Bactericide activity

One of the main causes of food spoilage is the microbial activity since it causes losses in the quality and safety of the product, therefore increasing the investigations of compounds with microbicidal activity that allow extending the shelf life and, above all, ensuring food free of pathogenic microorganisms (Smid & Gorris, 1999).

Prashanth et al. (2001), Carried out the first work in the evaluation of the antibacterial activity of *Punica granatum* in India for which an evaluation of the amount of sterols, alkaloids and tannins to the extracts was made in the foreground obtained with petroleum ether, chloroform, methane and water, this in order to identify which compounds were extracted with each solvent and which would have the activity in question for which it was observed that the extracts with the petroleum ether had a higher concentration of sterols, extracts with chloroform had a greater presence of alkaloids, extracts with methanol had mostly tannins and alkaloids and extracts with water had a greater amount of tannins. As for the antibacterial activity, the methanol extracts had the highest activity since the minimum inhibitory concentration in mg/ml was 6 for *Staphylococcus aureus* and *Bacillus subtilis*, and 1.5 for Proteus vulgaris concluding that the tannins and alkaloids affect the growth of these microorganisms significantly.

On the other hand, in 2009, was carried out a work with 6 varieties of pomegranate from the Mediterranean region of Turkey which were the Dikenli, Eksi, Kan, Katirbasi, Serife and Tatli varieties that were given. The bactericide activity was evaluated by agar diffusion (halo inhibition diameters) and the minimum inhibitory concentration (MIC) against *Bacillus megaterium bacteria, Pseudomonas aeruginosa, Staphylococcus aureus, Corynbacterium xerusis, Escherichia coli, Enterococcus faecate* and *Micrococus lucuscusis* and *Enterococcus* as in fungi *Kluvyeromyces marxianus, Rhodotorula rubra* and *Candida albicans*, observing that the extracts obtained from the aryls had growth inhibition of all the microorganisms used with halos of inhibition of 13 mm to 26 mm having the greatest effect on *E. coli* and the youngest in *E. faecalis* (Duman *et al*., 2009). Regarding the MIC, it was determined that it is above 90 µg / ml. In that same year was evaluated this same activity in vitro with diffusion tests in agar in situ (in food) using peel extracts with 80% methanol and using the bacteria of *Listeria monocytogenes, Staphylococcus aureus, Escherichia coli* and *Yersinia enterocolitica* showing a strong inhibition in the agar and with a MIC of 4 mg / ml, phytochemical analyzes were also concluded concluding that the presence of phenols and flavonoids was significant which were related to the observed antibacterial activity. The concentration of total phenols was 262.5 mg / g dry peel weight (Al-Zoreky, 2009).

Recently, and based on the results obtained in pomegranate extracts, Gullon *et al*., in 2016 carried out the antibacterial profile of pomegranate peel extracts by contacting the plant material (peel powder) with methane at 80% in water with the help of a centrifuge as well as the polyphenols present in the extracts were characterized obtaining minimum inhibitory concentrations between 20 to 50 mg / ml and whose antibacterial activity was the same for *Escherichia coli, Staphylococcus aureus, L. monocytogenes,* in smaller measure was for *Pseudomona aeroginosa* and the lowest activity was against *L. innocua*. Regarding the polyphenol profile, it was found that punicalagina is the compound with the highest presence being 16.67 mg/g of plant sample followed by ellagic acid being 0.15 mg/g of plant sample to which this activity is attributed. With regard to the year 2018 Kharchoufi et al. (2018), Evaluated their activity as an antifungal working in the same way with the peel but of the Gabsi variety in Italy against fungi of *Penicillium digitatum, Pseudomonas putida* and *Sacharomices cerevisiae* using methanol extraction with water and as solvent, observing that the greatest inhibition was presented against *P. putida,* followed by *P. digitatum* and lastly with *S. cerevisiae* which demonstrates that not only against pathogenic bacteria can the compounds present in the peel be useful. In addition, a polyphenol profile was carried out by HPLC and it was obtained that the compound with a majority presence is punicalagina followed by ellagic acid corroborating what was found by Gullon et al. (2016), And where these compounds would be responsible for the activity.

1.6 Antiviral activity

The use of polyphenolic compounds of pomegranate has been diverse even to combat viral diseases such as influenza A/H2N3 since in 2009 a work was carried out by Haidari et al. (2009), Where juice was used at a concentration of 70 ° Brix of the Wonderful variety working with MDCK cells for infection with the virus and see if there was a replication in the media and monolayers of the cells after the infection using the real-time PCR technique, observing a significant inhibition of proliferation as well as it can be determined that the concentrations of polyphenolic extracts, ellagic acid, caffeic acid, luteolin and punicalagina do not have a significant cytotoxic effect above 100 µg / ml, 50 µM, 20 µM, 10 µM and 100 µg / ml respectively.

1.7 Cardiovascular health

Atherosclerosis is a chronic and progressive disease that mostly affects medium-sized arteries. Clinically it manifests as ischemic heart disease, cerebrovascular disease or peripheral arterial disease (Lahoz & Mostaza, 2007). It has been observed that this disease is mainly caused by the oxidation of low-density lipoproteins (LDL), so delaying their oxidation reduces the risks of suffering from the disease. In 2010, was evaluated the effect of punicalagina, gallic acid and ellagic acid on the oxidation of LDL, observing that the former significantly delayed oxidation and, to a lesser extent, ellagic acid, it was also observed that with

the presence of these compounds the expression and secretion of important hepatocytes agents against the development of said oxidation was increased (Khateeb et al., 2010).

On the other hand, in previous work of 2009, was carried out the evaluation of pomegranate peel powder as a source of dietary fiber in hypercholesterolemia and atherosclerosis treatments indicating that, in doses of 5, 10 and 15 g/100 g of dietary supplement cholesterol, triglyceride, LDL and lipoperoxidation levels, tested in rats for 4 weeks, drop significantly (Hossin, 2009).

1.8 Anti-inflammatory activity

Inflammation, the first physiological defence system in the human body, can protect against injuries caused by physical wounds, poisons, etc. This defence system, also called short-term inflammation, can destroy infectious microorganisms, eliminate irritants and maintain normal physiological functions. However, long-term over-inflammation may cause dysfunctions of regular physiology (Lee et al., 2010).

Pomegranate has shown inhibition of nitric oxide (NO) in RAW 264.7 macrophage cells induced by lipopolysaccharides and a decrease in carragen-induced mouse leg edema was observed for 1,3,4 and 5 hrs, so in 2010 Lee et al., Used column chromatographic methods and in vitro bioassays to isolate anti-inflammatory compounds from the pomegranate peel such as punicalagina, punicalin, strictin, A and granatin B with acetone as solvent, it was observed that all the compounds were oxide inhibitors nitric and also inhibited the expression of iNOS in RAW 264.7 cells as well as there was an inhibition of mouse leg swelling, the specific effect of these compounds being verified.

In Peru, in 2015, was evaluated the application of alcoholic extracts added to a gel to reduce the inflammation of external hemorrhoids for which phytochemicals were extracted by maceration for 15 days using ethanol as a 70% solvent in water, which after to be added to a gel base, they were applied to volunteers of indistinct sex between 50 and 70 years for which two groups were made, group I was made up of 45 patients which were taken as a test to which the gel with the compounds of interest and group II is made up of 5 patients, the gel was applied to which the gel was applied but without compounds of interest. The treatment lasted 30 days and was applied twice a day, observing that at the end of the treatment there was a significant decrease in the inflammation of the hemorrhoids. To reinforce the work, flavonoids and tannins were quantified in alcoholic extracts, having significant amounts, which is why the anti-inflammatory effect is attributed to the presence of polyphenolic compounds (Bell, 2015).

2 Conclusions

Extractions and use of polyphenolic compounds from pomegranate have focused on the edible part of the fruit, as well as some parts of the plant such as roots and flowers, however, it has not deepened in extractions and characterizations of polyphenolic compounds of the fruit peel in varieties grown in Mexico, being specific, in the main producing states of the country such as Guanajuato, Hidalgo and even Michoacán, thus giving added value to the cultivation and production of the same since it is a plant source without limitation of work because this fraction of the fruit represents approximately 50% of the total weight and which is only discarded during processing. It has been observed in analyzes carried out on semi-desert plants in Mexico in 2013 where pomegranate peel was evaluated in 3 different maturation states (green, turnning and red) compared to other plants as governor (*Larrea tridentata Cov*.), Candelilla (*Euphorbia antisyphilitica Zucc*.), Hojaen (*DC Cernua Fluorencia*) and Dragon's Blood (*Jatropha dioica Cerv*.) Has the highest concentrations of polyphenolic compounds such as ellagic acid with a concentration of 61.1 mg/g of plant sample, 83.2 mg/g of plant sample and 85.8 mg/g of plant sample for green, turnning and red pomegranate husks respectively showing that this compound is an excellent source and that the content varies depending on the state of maturation, being found to a greater extent in the red grenades (Ascacio-Valdés et al., 2013).

The relevance of proposing proposals for alternative sources of polyphenolic compounds is important because of the multiple applications in the pharmaceutical sector and in the food industry. Ellagic acid, for example, which is attributed significant activity as an antioxidant and bactericide, may have difficulties at the time of being obtained at an industrial level due to the complexity of the structures of the elagitannins, of which it is a precursor, however it has been reported the production of this acid by means of cultures in solid medium using extracts of pomegranate peel as a carbon source reporting, in 2013, that the fungus *Asperguillus niger* GH1 is able to consume elagitannins and produce ellagic acid by what working with pomegranate varieties that have a greater amount of elagitannins can increase the production of ellagic acid by this means that is also faster than another and with less complexity (Ascacio-Valdés et al., 2013). Based on the above, there is a need to work with Mexican varieties to compare whether as a source of polyphenols they are ideal because they contain a greater presence of them.

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