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Characteristics Of Pomegranate Peel Extract And Its Components Obtained By Different Processes

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Abstract: Pomegranate (*Punicagranatum*) was originated in the Middle East but now grows in the Mediterranean, Chinese, American and SA areas. The pomegranate peel, juice, and seeds contain various nutritional compounds. Pomegranate peel is a rich source of hydrolysable tannins, phenols, and anthocyanin. Pomegranate peel is mostly worn out by industry. This review papers summarises the nutritional properties of pomegranate peel and its extract and its methods of extraction. Pomegranate peel has various functional properties such as anti-microbial, anti-inflammatory, antioxidant, ant mutagenic, anti-cancer activity, etc. due to total phenolic compounds that are phytochemicals in Pomegranate peel. Some techniques such as ultrasound-assisted, HVED, citric acid, high pressure and enzymatic assisted extraction of PP in which high pressure is the more effective technique for extracting various compounds from pomegranate peel because it minimized the compound damage losses. PP is a rich source of various functional compounds and consumers should switch to natural compounds in order to benefit their wellbeing.

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1. Introduction

Pomegranate *(Punicagranatum)* belongs to punicacae family and is deciduous tree (Ali et al., 2019). This small tree firstly was found in Middle East but now growing in South Africa, China and America (Kharchoufi et al., 2018). In North and South America even in Europe, it has significance as a decorative tree and shrub (Ali et al., 2019). Iran is one of the principal cultivars of Pomegranate (Sharayei et al., 2019). Pomegranate is also known as the seeded apple orapple granulate. The name pomegranate is derived from the Latin word pomum (meaning "apple") and granatum (meaning "sown"). The fruit is considered as a sign of good fortune. It is the tiny tree that grows to 5-8/m and bears about 100-200 fruits at a time. The fruits are eaten fresh or processed as juice, jams and wine (Pathak et al., 2019). Pomegranate is red thick fruit and its skin is wasted during processing. It has a medium weight of 330 g and a size of 70-80mm. Its juice color is red and its juice yield is an average of 70ml/100g. Pomegranate is composed of 3 parts of seed, peel, and juice (Kharchoufi et al., 2018). It is a small berry with thick reddish skin covering between 200-1400 white to deep red or violet seeds (Ali et al., 2019).

Pomegranate weight is divided into different fractions including peel 50%, arils 40%, and seed 10%. Peel is considered as very important due to nutritional properties comprising phenolic compounds and hydrolysable tannins. These phenolic compounds are responsible for the antioxidant properties of 92% of the fruit (Pathak et al., 2017).Due to its antioxidants; antiviral, anti-mutagenic and anti-cancer properties it has been proved necessary for human health. Pomegranate seeds are edible and have a good antioxidant, anti-inflammatory potential because of higher anthocyanin contents and hydrolysable tannins (Ali et al., 2019). The pomegranate phytochemicals modulate pro-apoptotic protein transcription factors, anti-apoptotic proteins kinases, cell adhesion molecules, pro-inflammatory mediators and growth factors in various cancers (Sharma et al., 2017).

Pomegranate is used as a medicinal plant to cure a variety of illnesses and diseases. In the medicinal system of India, pomegranate is considered as a yurvedic medicine which is the whole pharmacy itself. It was used to treat diarrhea and ulcer and act as an anti-parasitic agent. Antimicrobial activities of the plant are mainly attributed for the treatment of

dermato-mucosal diseases. In the medicinal system of Greek, pomegranate is seen as critical to cure the diabetes. Remarkably not only fruit but peel, bark, leaves and seeds are also known for the nutritious, medicinal and therapeutic properties. (Sharma et al., 2017). It is also involved in decreasing the infestation of tapeworm. Furthermore, numerous pre-clinical studies suggested that pomegranate juice consumption or peel extract under suitable conditions improves the sperm quality of mice, lowers the amyloid deposition of Alzheimer's disease in a rat study and lessen the neuronal damage. It also constitutes a rich source of ellagic acids. Hydroalcohlic extracts have significant antibacterial activity and therefore are effective for the treatment of dental plaques (Wang et al., 2018).

Pomegranate peel is considered as important part of nutritional values for the other two parts. Peel plays an important role in infectious diseases (Kharchoufi et al., 2018). It was admired by the Old Testament of the Bible as "A divine fruit deliberating the power of productivity, abundance and good fortune" (Wang et al., 2018). Pomegranate peel waste is important for the creation of an extract deep in natural antioxidants which have authenticated increased requirement in recent years due to the health awareness of the population.

Pomegranate peel is the good fountain of anthocyanin, phenolic compounds, vitamins and minerals. These compounds are beneficial to health (Shahid et al., 2021; Leghari et al., 2021). It has been noted to have many absolute health welfare including anti-inflammatory and anti-atherosclerotic characteristics as well as other advantages such as chemoprevention (Özdemir et al., 2017). Natural solvents such as methanol, di-ethylene ether, and acetone are used to extract antioxidants from plants. The pomegranate peel components are hygroscopic so they must be mixed with the bulking agents during the drying (Sandhya et al., 2018).

Health benefits are not limited to the edible portion of pomegranate but are also found in non-edible portions. Non-edible portion rich in more biologically active compounds than edible portion (Shahid et al., 2021). A plethora of compounds found in the pomegranate peel makes it cheap potential source for the production of antioxidant rich dietary foods. Due to excess of anthocyanin and antioxidant characteristics compared with the edible proportion, the dark red color of pomegranate peel is an important quality attributed to customer demand in the market (Singh et al., 2019). Because pomegranate peels have antimicrobial, anticancer, anti-obesity, genetic anti-ulcer, Anti-diabetic, anti-hypertensive and anti-mutagenic properties, it has been recognized as a good source of dietary antioxidant with potential therapeutic benefits (Zhu et al., 2013).

Similar to the antioxidant activity of vitamin E, B-carotene and ascorbic acids, the combination of a wide array of polyphenols renders its operations unique. Pomegranate fruit has higher antioxidant activity similar to red wine and green tea anthocyanin. Pomegranate peel is a significant result and is a rich wellspring of bioactive mixes which lessens the danger of cardiovascular ailments. The dried peel can be used to treat headaches and stomach problems (Singh et al., 2019).

Extraction is the essential process to isolate the active ingredients. Distinctive ordinary techniques for extracting phytochemicals from the pomegranate peel including refining and natural dissolvable extractions were used (Xi et al 2017). Conventional methods are not advantageous due to the consumption of a high amount of solvents, long operation time, high costs, low extraction yield and detrimental effects on compounds due to usage of high temperature (Alexandre et al., 2017). Some other techniques are pressurized water extraction, moment controlled weight drop and ultrasound extraction having low vitality and higher little consideration regarding utilization of higher voltage electric release (Xi et al., 2017). High-pressure extraction, citric acid extraction, enzymatic assisted extraction, high voltage electric discharge, and ultrasound-assisted extractions are recent techniques. High-pressure extraction is the technique in which no detrimental effects occur because no heat is used in this technique. It is green technology (Huang et al., 2013). Enzymatic assisted extraction technique involves the degradation of the cell walls with help of enzymes i.e. glucanases and pectinases which render the intracellular components more accessible for extraction by weakening and breaking the cell walls (Li et al., 2006). This review is designed to explore knowledge about different biologically active ingredients present in pomegranate peel and their importance in human health.

2. Extraction of Pomegranate Peel

2.1. Aqueous and Ethanol Extract of PP (Pomegranate Peel):

Aqueous pomegranate peel extract displayed a lower antioxidant activity ($p<0.05$) than an ethanol extract at both concentrations (1:15 and 1:60). It was attributed to the disparity in solubility of the antioxidant activity imparted by the phenolic compounds. Higher antioxidant activity is due to the greater pomegranate peel concentration (Negi et al., 2003).Ethanol was found to be more effective for PP extraction. Because the amounts of TPCs in ethanol extract is higher than that of aqueous extract. It was

so that the lesser solubility of PP in water than ethanol (Cam and Hisil, 2010). So ethanol was chosen to extract the phenolic compounds from PP at a ratio of 1:15.

The removal of ethanol and easy handling the ethanol PPE was dried by oven. Whey protein and skimmed milk powder used as an aid. The 6 different levels (2, 3.5, 5, 10, 15 and 20) % of Whey protein contents (WPC-70) and 5 different levels (3.5, 5, 10, 15 and 20) % of Skimmed milk powder (SMP) were incorporated with PPE. The antioxidant and total phenolic contents (TPC) decreased markedly ($P<0.05$) with increased drying aid level. It could be attributed to the dilution effect of the drying aid which decreased the TPC and antioxidant activity (Caliskan&Dirim, 2013). Georgetti et al, (2008) stated that the chemical structure of the active ingredients and their drying aid interactions also affect the extract's antioxidants function.

In all concentrations, SMP added powder demonstrated lower antioxidant activity than WPC-70 added powder due to the presence of sulfhydryl group (SH) across whey protein that has free radical scavenging capability. The highest antioxidant activity in PPE for the 3.5 percent SMP and 2percent WPC-70 with a higher concentration of drying aid drastically decreased the antioxidant activity. When protein polyphenols interaction increases which decreases the availability of free radical binding sites (Rohn et al., 2004). TPC and antioxidant activity increased with increasing PPE. The flavor score of the curd sample rate is inversely proportional to both PPE powder. This is because the pomegranate peel extract has an astringent flavor (Dinnella et al., 2009). Body and texture score of 0.5 percent WPC-70 dependent PPE added curd sample showed markedly slightly higher values than control and score decreased ($P<0.05$) with an additional increase in PPE powder amount. Color and appearance scores didn't show any significant ($P<0.05$) changes till 1percent level of both PPE powders. However, in both PPE powder added curd it decreased markedly ($P<0.05$) at a level of 1.5 percent.

Overall acceptability score ((OA) decreased as PPE powder grew. The OA scores remained unchanged when compared to control at 0.5 percent of PPE powder, and as the PPE concentration increased, the OA score decreased markedly ($p<0.05$ percent). During storage time the titrable acidity of all samples increased markedly ($P<.05$) (Wasilla et al., 2014). During the storage cycle the microbial PPE count decreased markedly. While in regulated curd the storage increases until 3rd day and decreased acidity. The decline in the count of microbial is due to increased acidity. Curd PPE samples added demonstrate resistance to microorganisms due to PPE's antimicrobial activity (Sandhya et al., 2018). So, it is reviewed that ethanol extract is the best one than aqueous-based extract because PP is more soluble in ethanol than water. The antioxidant activity and TPC level are higher of WPC-70 based extract than SMP based powder because of the presence of a sulfhydryl group in whey protein and its scavenging ability. The evaluation affected by both extracts like flavor decreased by the addition of both drying aids, body texture first increased then decreased with addition, OA decreased with increased drying aids and TA increased so microbial count decreased (Tabaraki et al., 2012).

Table 1. Different compounds under 60 degree Celsius for 30min in ethanol mixture:

TPC	93.65mg/100g DW
FRAP	63.10mmol $Fe^{2+/}$100g DW
DPPH	84.10%
yield	46.98%

2.2. Ultra-Sound Assisted Extraction of Bioactive Compounds:

Conventional methods such as SOXH, maceration, and hydro-distillation extraction are most common. However these are not more advantageous due to time-consuming, demand for pure solvents, their costs and damage to thermo-liable compounds. An ultra sound extraction is one of the effective techniques for extraction as compared to conventional techniques. It has creation benefits such as shorter running time, smoother operation, decreased solvent consumption and temperature, energy savings and improved yields. Due to the cavitations process, UAE can increase the yield and improve the mass transfer (Vilkhu et al., 2008). UAE has been affected by various factors, such assonicity, frequency, ultrasonic wave distribution (Chemat et al., 2017). RSM (Response Surface Methodology) is used to determine the various effects of ultrasound amplitude and ultrasound exposure time on POPx'sthe qualitative and quantitative properties (Sharayei et al., 2019). Many solvents have to come in previous studies to extract the antioxidant and phenolic compounds from pomegranate peel such as acetone and methanol (Li et al., 2006; Negi and Jayaprakasha, 2003; Singh, Chidambara, and Jayaprakasha, 2002; Viuda-Martos et al., 2011; Yasoubi et al., 2010). The US Food Drug administration then suggested the organic solvents, such as water and ethanol (Bartnik et al., 2006).

Following the development of different models for different responses such as FRAP (Ferric Reduction Antioxidant Power), yield, TPC (Total Phenolic Contents), DPPH (diphenyl-1-picrylhydrazyl) and IC50, etc. The different variables optimized to take into account the targeted outputs. Input included parameter such as UET (Ultrasonic Exposure Time) with experimental range, UA (Ursolic Acid) reached up to 60 percent which is the economic range and the objective was to get maximum TPC, yield, FRAP and DPPH, and minimum IC50 from POPx. To achieve optimal values, optimal conditions were employed. Under these conditions responses for predicted values of IC50, DPPH, TPC, and yield decreased 15.9%, 3.19, 3.16 and 20.64% respectively and FRAP raised 0.93% as compared to predicted values (Pan et al., 2012). By comparing, the different extraction techniques to get extract of antioxidants from pomegranate peel and recorded 60 min extraction time and 59.2 W/cm2 level of intensity under optimal conditions. Using the Ultrasound technique was observed to significantly increased (by 22-24%) and antioxidant activity (by 13-24%) but decreased the energy consumption and extraction time (by 87-90percent). Tabaraki et al., (2012) indicated that optimum condition for the UAE was the temperature 60 degree Celsius for 30 min, the ethanol-water mixture as a solvent of 70 percent.

The yield from extraction is determined by the UA and UET. The higher UA and longer exposure time obtained by the maximum yield because they both are synergic and improve the extraction yield. The intensity of the extraction also increased by increasing the amplitude at a given frequency and increasing the frequency at given amplitude. The extraction yield increased by increasing the amplitude due to this compression, refraction cycles and delivery of ultrasonic effects also increased (Al-Dhabi et al., 2017). Carrera et al., (2012) suggested that ultrasonic amplitude and cavitations effect have direct relation so higher ultrasonic amplitude improves the extraction yield. Vilkhu et al., (2008) and Ghafoor et al., (2009) also expressed that main reason is the cavitations phenomenon in the ultrasonic process for improvement of extraction yield. Cavitation phenomenon increases the permeability of the plant tissues. There may be a risk for the destruction of some natural compounds due to the higher ultrasonic intensity so the optimization is necessary. For the ecofriendly extraction, there may be the low UET required for initiation of the process (Paniwnyk et al., 2009). Both UA and UET have an essential role in the getting output of phenolic compounds. TPC increased gradually with increasing the UET but it increased slowly with increasing the UA. TPC reached a peak level with 60% UA. Li et al., (2006) described that peel's higher antioxidant activity causes a higher amount of flavonoids, pro-anthocyanin, and phenolic. Greater diffusion occurred of target compounds by increasing the UET because it increases the residence of the POP in solvents. These effects may also increase by increasing UA simultaneously. So the extraction yield increased by UA and UET but optimization is necessary.

There is a significant role of the UA and UET on the antioxidant activity of PPE. FRAP decreased with increasing the UET but enhanced readily by rising the UA until 60percent and then slightly decreased. It was reported in many studies that polyphenols of the pomegranate peel have antioxidant activities (Almeida et al., 2016; Csepregi et al., 2016). Nogala-Kalucka et al., (2005) did thanks to the antioxidant activities of polyphenols because they helped to remove heavy metals, free radicals and controlling the manufacturing of hydro-peroxides in plant cells. Wang et al., (2011) described that DPPH antioxidant activity has a direct relation with the TPC. DPPH values decreased with gradually increasing the UET value for 5-15 min but increased with increasing the UA value 60%. There is the inverse relation between IC50and the inhibition power. There was an increment in IC50 with increasing the UA up to 60% but decreased further with UA.

UAE technique increased the yield by 143 percent without any disturbance of the carotenoid and other compounds as compare to the other traditional techniques. This technique is time-saving and also enhanced the extraction yield and also improved the recovery of the compound's losses which are thermo-liable. This technique can be used under optimal condition such as UA 60%.

Table 3. UA (60%) and UET (6.2min):

TPC	3.16% decreased
IC500	15.9% decreased
DPPH	3.19% decreased
FRAP	0.93% raised
Yield	20.64% decreased

(Pan et al., 2012)

Table 4. Impact of UA technique:

Antioxidant activity	13-24% increased
Time	87-90% decreased
Yield	22-24% increased

2.3. Optimization of UAE under different conditions

Optimization of UAE under different conditions is shown in Table 1, 2, 3 and 4.

2.4. High voltage electrical discharge (HVED) assisted pomegranate peel (PP) extraction:

Because of their antioxidant activity phenolic compounds found in pomegranate peel, seeds and pulp are very beneficial to human health by protecting their cells from various stimulated oxidative stress and cell death (Nawaz et al., 2006). The phenolic compounds in the peel are higher than pulp and seeds so they have greater antioxidant activity. Several studies have reported how phenolic compounds are extracted. The conventional methods are the distillation and extraction of organic solvents. They are time-consuming methods and are tedious; also have negative environmental impacts because of the emission of volatile compounds. Some new techniques are instant pressure drop UAE, supercritical fluid extraction and quick extraction of pressurized water with high extraction capacity, and HVED. HVED is technique used without heat .The basic purpose associated to mass-transfer of natural ingredients in liquids with a shorter time at room temperature. This technique used pulsed voltages (20-80kv/cm electric field intensity) by the electric gap below the surface of aqueous suspension of natural material which based on the electrical liquid breakdown phenomenon (Xi et al., 2017). HVED is a technique used without heat so it is advantageous to the heat-labile compounds and protect them from thermal destruction.

The increase in material flow rate from 8 to 10 ml/min enhanced the efficiency of the extraction of phenolic compounds because the width of the boundary layer decreased with flow rate and more phenolic compounds extracted into a solvent (Psillakis and Kalogerakis, 2001). Further increment in flow rate decreased the extraction yield because of the sample solution's linear velocity was too high to reach the extraction equilibrium in the phase boundary layer. The electrode gap difference also affected the yield of phenolic compounds. Different electrodes at flow rate 10ml/min had the liquid to solid ratio of 30ml/g and with gapes of 2, 3, 4 and 5 mm. The difference in gapes of electrodes adjusted also helped in the electric field intensity. The increment of distance helped to decrease the electric field intensity (Brianceau et al., 2016; Liu et al., 2011).

The phenolic compounds yield increased when the distance of electrodes enhanced from 2-3mm but yield lowered when difference more than 3mm. The discharged intensity reduced due to the weak electric field at a higher gap than 3mm so this gap considered optimum. So the electrical field intensity had a strong effect on the phenolic compounds extraction yield as reported by (Brianceau et al., 2016; Sarkis et al., 2015). There may be a reason of higher extraction yield by the HVED due to the great damage of cell membrane by high electric field intensity which makes easy to move out the compounds from cells to solvent (Boussetta, et al., 2013; Boussetta&Vorobiev, 2014; Brianceau et al., 2016). The liquid/solid ratio also affected the yield which examined 20, 30, 40 and 50ml/g. The extraction yield was increased up to 20-30ml/g but above the 30ml/g decreased mildly because of at electrodes gape 3mm, 31min, the flow rate of material 10ml/min and 30kV/cm intensity. Because of larger volume of the solvent the larger extraction obtained which dissolves a higher amount of phenolic compounds (Zhang et al., 2011).

2.5. High pressure extraction (HPE) of PPE:

High-pressure extraction is a methodology in which no heat is used. This technique used plant material for the extraction of active ingredients. It is also used to avoid these ingredients from heat and pressure and also their biological activities (Huang et al., 2013). This technique provides a higher yield than conventional methods so called green technology. Higher pressure technique which used pressure up to 100-800MPa or 1000MPa can disrupt the structural quality material. Such as denaturation of proteins, damages of organelle, deformation of cell (Prasad et al., 2009). Solubilization of the active ingredients occurred in this process.

It usually used a range of total extraction yield (TEY) is between 39-41%. TEY increased by HPE 3-8% in comparison of extraction under atmospheric conditions (the pressure under absence or presence of enzymes). Alexandre et al., (2017) found that ethanol extraction increased the TEY 3-6% for pomegranate obtained at 300Mpa and 600Mpa respectively. HPE extraction showed the highest TPC accounting at 300-600MPa which described that an increase up to 9-5% as compared to control conditions. Alexandre et al., (2017) obtained a TPC increase up to 6 and 12% for ethanol extraction at 600 and 300Mpa respectively .There is no significant difference in TPC from enzymatic extraction when compared to controlled extraction. High pressure increases the extraction yield and total phenolic content. Efficiency of HPE is discussed in Table 5.

The UV spectra and MS data was compare for identification of components. With literature some major contents of all extract are two

punicalagin isomer , Quinic acid, two bis-HHDP-glucoside isomers penicillin isomer, 2-o-galloylpunicalagin, , galloyl-HHDP-glucoside and digalloylpentoside Some are found in lower amounts which are Ellagic acid and ellagic acid-O-hexoside. Punicalagin is found in nature alpha and beta two anomers forms but usually mentioned as punicalagin (Kazemi et al., 2016). Punicalagin were the main components. Bis HHDP-glucoside is the isomer which is the major second component of all extract yields. HPE increased the extraction of six compounds. In both combinations, the extraction of only four compounds is increased as compared to control extraction.

This proved that there are some phenolic compounds which cause an increase in antioxidant activity. There was more difference in pressure interior surface and the exterior surface of the cell and due to this property, the rapid permeation occurred which helped to see the impact of HPE. Solvent penetration into cells and the mass transfer rate is enhanced by the cellular walls disruption and hydrophobic bonds in the cells (Oey et al., 2008). The higher pressure is responsible for the increase phenolic compounds extraction which leads to the antioxidant activity.

Antimicrobial activity of the extract is tested .This activity was against the many food pathogens lab. Sterile water didn't show any inhibition .Initial screening of antimicrobial activity, it proved that most of the microbes are sensitive to extract. Pseudomonas aeruginosa is the microorganism that has the highest inhibition and more sensitive to extract than most of the others. There is no more difference inhibition observed between control extract or obtained by high pressure. The correlation between TPC\inhibition and AA\inhibition haloes relatively high with an average 0.8 and 0.7 respectively (Alexandre et al., 2019). The inhibition halo increased with high pressure which increased the antimicrobial activity.

Table 5. Efficiency of HPE:

Extraction yield	9-5%	300-600MPa
TPC	6-12%	300-600MPa

(Alexandre et al., 2017)

2.6. Minimum bacterial Minimum Inhibitory concentration (MBC and MIC):

There is no difference between MBC and MIC obtained from pressurized or unpressurized extracts. They have low MBC and MIC like 31.25 and 0.98 mg\ml respectively .In the case of the EE with or without pressure, all MBC obtained for each bacterium were equal for extracts obtained from pressure or without pressure. The haloes of pressurized extracts were higher AA, TPC of EE are higher for pressurized extracts. The MBC and MIC for all extracts were lower for the Gram-positive bacteria means that these bacteria are more sensitive due to property of Gram –Negative bacteria having the lipopolysaccharides in their membrane (Naz et al., 2007). By this, it was showed that the pressure condition which are applied have a positive impact on extraction yield, total phenolic contents quantified by folin-ciocalteu method, individual phenolic contents by AA and HPLC of the extract.

When sample was subjected to the 300MPa, it shows the highest value of the antioxidant capacity and maximum TPC. The increase in the pressure increased the extraction of different isomers as punicalagin isomers, digalloylpentoside, bis HHDP-glucoside isomer, ellagic acid, ellagic acid-o-hexoside, and apigenin-o-hexoside. But only galloyl-HHDP-glucoside decreased with an increase in HPE at 600MPa. EE did not give better results for TEY when compared to the extraction obtained by without HP. Bis-HHDP-glucoside, Punicalagin isomer and digalloylpentoside are the compounds extracted from EE better results than others (Alexandre et al., 2019). The MIC is lower for the HPE but MBC and MIC lowered for gram-positive bacteria due to lipopolysaccharides in their membranes.

Table 6. MIC for Controlled and Pressurized Extract:

	Controlled Extract	Pressurized Extract
S.aureus	15.63mg/ml	7.82mg/ml
L.momocytogenes	31.25mg/ml	15.63mg/ml
MRSA	7.82mg/ml	3.91mg/ml

(Naz et al., 2007)

2.7. Enzymatic Assisted Extraction (EE) of PPE:

Enzymatic extraction is another technique that is used to extract the active material. Natural sources are used for the production of active materials. The mechanism involves the degradation of cell wall through enzymes. Intracellular material is available for extraction. EE increased in the extraction of the 3 compounds named, digalloylpentoside, bis HHDP-glucoside isomer, punicalagin isomer and EE yield 145.05ug/g DW Bis-HHDP. EE increased the extraction of 4 compounds with a combination of HPE bis-HHDP glucoside isomers, ellagic acids, ellagic acid hexoses,

and digalloylpentoside. EE used for the phenolic compounds extraction, but no impact seems on the AA and TPC extraction from pomegranate peel. So it seems that the enzymes promoted the linkages of phenolic compounds inside the cells and decreased their availability (Laroze et al., 2010). In similar to control extract the EE exhibited the AA, TPC and phenolic contents quantified individually and the lower inhibition halo than control extract. So the most part of the correlation between TPC\inhibition and AA\ inhibition was 0.8 and 0.7 respectively with few exceptions (Alexandre et al., 2019).

Conclusion:

The conclusion is that the utilization of Pomegranate has been increased due to many health benefits. Agro-industrial by-products as Pomegranate peel have become more popular in the community of scientific due to the presence of biologically active synthesis like phenols. Phenols are characterized by antimicrobial and antioxidant activities. These activities of pomegranate peel increase by increasing the concentration of the starch matrix due to the increment of the inhibition zone. Same in case of curd increased after the addition of PPE because of increment in acidity. In Pomegranate peel, different compounds like flavonoids, phenolic acids, hydrolysable tannins, and anthocyanin are present. Biologically active compounds of pomegranate peel proved to be antioxidant and hepato-protective having lower toxicity or without toxicity. Biologically active compounds from pomegranate peel are extracted by using different conventional methods, such as Soxhlet extraction, maceration, and hydro-distillation extraction .These methods were not advantageous because they are time-consuming, demand pure solvents, expensive and damage thermo-liable compounds. So, some techniques nowadays are utilizing for the extraction of these biologically active components like Ultra-sound-assisted extraction which increases the yield due to cavitation phenomenon and mass transfer, HVED that is non-thermal technique for mass transfer of natural ingredients in liquids having shorter time at room temperature and High-pressure extraction which increases the yield 3-8% without using heat and called Green technology. By this review, summarizes that Pomegranate peel has the ability not only used as a natural food preservative but also as a health supplement due to its enrichment in functional properties. For the replacement of chemical additives with natural compounds occurred in Pomegranate peel some more studies needed at Pomegranate peel.

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