Pomegranate (*Punica granatum*) Peels Powder as a Promising Application in Green Technology

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ABSTRACT

Peels with rinds of Wonderful cultivar pomegranate were used. Pomegranate wastes (PW) globally represent 1.62 million tons. Such wastes have a detrimental effect to the environment and contribute to methane emissions. An application of green technology to minimize processing wastes was suggested. Hot air and vacuum drying of PW resulted in pomegranate peel powder (PPP). The hot air dried and vacuum dried of PPP contained pectin (10.9 & 14.9 %) , total phenols (125 & 151.7) as gallic acid equivalent /g, neutral detergent fiber (15.8 & 12.3), acid detergent fiber (9.1 &6.6), lignin (2.4 &1.6), cellulose (6.7 & 5.0), and hemi-cellulose(6.8 & 5.7%), respectively. The PPP was found to be rich in potassium, sodium, calcium and phosphorus, in addition to iron, zinc, and manganese. Three methods for extraction pectin and total polyphenols from PPP were investigated. The three extraction methods are hydrochloric acid extraction, hydrothermal extraction, and a novel method of probe sonication with cellulase. The extraction of pectin ranged between 4.5 to 11.0 %, and total phenols 51.4 to 108.6 mg gallic acid equivalent/g. Hydrochloric acid extraction showed the highest pectin and total phenols yield. The yield from the three extraction methods is low and the three methods are energy and time consuming, and are sources of corrosive chemicals. In conclusion drying PW is considered a beneficial green technology for extending the shelf-life of PW. The dehydration resulted in PPP rich in many bioactive components and minerals with acceptable colour.

***Keywords:* *Pomegranate, fibers, pectin, phenols, minerals, colour*.**

INTRODUCTION

Food processing wastes represent huge amounts of liquid and solid disposable materials. Such wastes though they are generally rich in organic matter, yet they have a powerful negative impact on the environment EPA (2016). According to Lieber (2019) and EPA (2020) food wastes beside their detrimental effect to the environment, they contribute significantly to climate change through their contribution of 18 % of methane emissions, where fruits and vegetable wastes represent 30 % to 40 % of that methane emission. Food industries are markedly developed and increasing world wide. Accordingly, control of food wastes and food processing wastes is essentially considered under the umbrella of white biotechnology and green technology. Vegetables and fruits processing wastes are of high value added components, as rich sources of numerous technological and functional health components.

The Pomegranate fruit (*Punica granatum*) is one of the oldest edible fruits, of *Punicaceae* family. The fruits arils can be consumed fresh, pressed for fresh healthy drinks, or processed as juices, syrups, jellies, jams, beverages, natural colouring, and flavouring agents. The rind and seeds of the fruit processing as waste components represent 54 % of the fruit weight. In California, USA about 218,000 tons of pomegranates results in about 118,000 tons of wastes, according to Lieber (2019).

Magangana *et. al*. (2020) and Katharine *et. al.* (2021) stated that the production of pomegranate globally amounted to 3 million tons, representing about 1.62 million tons of waste. Pomegranate juice represents about 46 % of the fruit weight and it is the base for many delicious products, while the rinds and the seeds of the fruit comprise 43 % and 11 %, respectively of the fruit weight. Pomegranate processing wastes (PPW), and pomegranate peel powder (PPP) are rich sources of many bioactive components as pectin, antioxidants, pigments, as well as flavouring agents, minerals, crud fibers, and natural antimicrobial components.

The main Egyptian pomegranate cultivars are Sahrawi, Edkawy, Manfaloty, and recently Wonderful cultivar is introduced and cultivated, (Abdel-

Salam, 2017, and Abdel-Salam, *et al*., 2018). In the present study the fruit peels of Wonderful, were used as being the most recent pomegranate cultivar. That is to investigate the use of PPW or PPP of the Wonderful cultivar pomegranate as source of nutrients and bioactive components for further technological use in food products .That aims to evaluate the chemical, functional and technological properties of the pomegranate peels, for further use to add an economic value to the fruit processing waste, through an application of green technology.

MATERIALS AND METHODS

Materials

Wonderful cultivar pomegranate fruits were purchased from the local fruits market in Alexandria governorate, Egypt. All the chemical reagents used were of analytical grade. Cellulase (E.C.3.2.1.4) of *Aspergillus niger* was used. The enzyme has an activity of 118 U/mg, and was obtained from NACALAI TESQUE, INC. KYOTO, JAPAN.

Methods

Pomegranate peel wastes: Pomegranate fruits were washed, peeled and arils were removed manually, then pomegranate peel wastes (PPW) were separated into two parts, the first part of the fresh peels were packed in polyethylene bags stored at -12° C until further use, while the second part was dried to a constant weight. Drying was carried out at 50^{o}C using either an air oven or under vacuum oven (Model 3618, USA). Dried peels were ground using a laboratory blender (Moulinex, AR 1044, France) and passed through 180 and 500 µm sieves for under vacuum dried peels and hot air oven dried peels, respectively. Finally, the powders were packed in polyethylene bags and stored at 4° C until used.

Colour measurement: The colour values, namely, lightness (L*), redness (a*) and yellowness (b*) of samples were measured using a Hunter Lab Ultra Scan VIS model, colorimeter (USA) according to Santipanichwing & Suphantharika, (2007). The instrument was standardized during each sample measurement with black and awhite. The total colour difference ΔE was calculated using the following formula:

$$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1\backslash 2}$$

Where ΔL^{*2}, Δa^{*2} and Δb^{*2} are the difference between reference and samples.

Chemical methods: Proximate composition and all the chemical determinations were carried out in triplicates. The results are expressed on dry weight basis.

Moisture: Moisture content of samples was determined by drying them in an air oven (FISHER ISOTEMP OVEN 300 SERIES, Model 350G, USA) at 105°C to a constant weight according to the A.O.A.C. method No 954.43 (2006).

Ash: Ash content was determined according to the A.O.A.C. No 923.03 (2006). The sample was ignited after pre-ashing in a muffle furnace (NEYCRAFT JFF 2000, USA) at 550 °C.

Crude fiber: Crude fiber content was determined as described by the A.O.A.C. method No. 935.53 (2006).

Total carbohydrates: Total carbohydrates were calculated by difference using the equation: Total carbohydrates= 100 - (fat+ protein+ ash)

Minerals content : Calcium (Ca), iron (Fe), zinc (Zn) and manganese (Mn) were determined in ash solution (prepared as described by A.O.A.C method No 968.08, (2003) using an atomic absorption spectrometer (Model Thermo SCIENTIFIC S SERIES AA, India), while sodium (Na) and potassium (K) were determined using a flame analyzer photometer (Model JENWAY, England). Phosphorus content was determined colourimetrically at a wavelength of 410 nm by phosphomolybdate reagent according to Kalra (1998).

Dietary fiber: Neutral detergent fibers (NDF), which include cellulose, hemicellulose and lignin as well as acid detergent fibers (ADF) containing cellulose and lignin were determined according to the A.O.A.C. method No 985.29 (2006).

Total phenols: Phenolic extracts were prepared according to Reddy & Mathew (2001). Folin-Ciocalteu spectrophotometric method as described by El -Falleh *et al*. (2012) was used to determine the total phenolic content in the methanolic extract.

Pectin: Pectin content was determined as calcium pectate according to Ranganna (1995), where 100 g pectin $\simeq$ 102 g calcium pectate .

Aqueous-acid extraction: Aqueous acid extraction of pectin from hot air oven dried peels was carried out according to Mouna *et al*. (2017) with some modifications. Where hydrochloric acid was used for extraction instead of nitric acid, at 50^{o}C for 1h . Total phenols content was determined in an ethanolic aqueous extract according to El -Falleh *et al*. (2012).

Hydrothermal extraction: Hydrothermal extraction of pectin from fresh ground peels was carried out according to Talekar *et al*. (2018). Total phenols content was determined in an ethanolic aqueous extract according to El -Falleh *et al*. (2012).

Ultrasound and cellulase extraction: Enzymatic extraction of pectin from under vacuum dried pomegranate peels powder was carried out according to the novel recyclable approach designed by Talekar *et. al*. (2019), with some modifications. Ultrasound treatment was carried out by using a probe (BANDELIN SONOPULS electronic TYP:UW 2070, Germany) for 6 min at a power of 90% and 8 cycles . Then, the cellulase [E.C.3.2.1.4 from *Aspergillus niger,* 118 U/mg, NACALAI TESQUE, INC. KYOTO, JAPAN] was used at an enzyme activity of 65U/ g of peel powder and shaken at 180 rpm with a shaker bath (Model 3540-I, LAB-LINE INSTRUMENTS, Inc., India) at 50 °C for 4 h, followed by centrifugation (BECKMAN Model J-21C centrifuge, USA) at 2840 xg for 20 min. Total phenols content was determined in an ethanolic aqueous extract according to El -Falleh *et al*. (2012).

RESULTS AND DISCUSSION

Moisture: Pomegranate peel is high in moisture content and cannot be stored for further use without the application of a proper preservation method. Dehydration is a vital step in reducing the moisture content for preservation purposes and increasing the shelf life. Most of the conventional thermal treatments such as hot-air drying, vacuum drying and sun drying are used for food preservation primarily intended to inactivate enzymes, deteriorative microorganisms and reduce water activity.

The results presented in Table (1) indicate that the moisture of fresh pomegranate peels was 73.97 %. These findings agree with those mentioned by Katharine *et al*. (2021) which showed that the moisture content of fresh pomegranate rind ranged from 67.26 to 73.23%. The moisture content of the dried PPP was 13.76% and 13.78% for hot air oven dried peels and under vacuum dried peels, respectively. Rowayshed *et al*. (2013), Jalal *et al*. (2018), and Rajintha *et al*. (2018) showed that the moisture content of PPP ranged from 7.27 to 13.7% using an air circulatory tray drier at 60°C. Accordingly, the selection of the proper drying method may be influenced by several factors, such as the product type, availability of the drying equipment, drying conditions, cost of the drying operation, and the drying efficiency.

The oven drying technique for pomegranate peel has been shown to improve the quality of the dried pomegranate peel material. It is easily accessible and economical. However, it may reduce the integrity of the product from its original state due to the use of high temperatures and prolonged drying periods during the process. Vacuum drying can be a useful technique for solid products that are heat-sensitive. Yet, the technique is energy- and cost-effective, with short drying times at low temperatures that do not damage the product. Another advantage of applying this method is that it does not cause corrosion issues and is environmentally friendly. Unfortunately, for large-scale production, it may not be as cost-effective according to Magangana *et al*. (2020).

Pectin: Table (1) gives the percentages of pectin that were equivalent to calcium pectate. Fresh pomegranate peels contained 10.83% pectin, while hot air oven dried pomegranate peels and under vacuum dried pomegranate peels contained 10.63 % and 14.93% pectin, respectively. It was found that under vacuum dried pomegranate peels powder showed higher pectin content than hot air oven dried and fresh peels. Abdel-Salam (2017) found that the pectin content of the dried pomegranate peels was 4.26%, which is markedly lower than that

Table 1: Moisture, pectin, and total phenols of pomegranate peel wastes (on dry weight basis).

Component \ Treatment	Fresh peels	Hot air oven dried peels	Under vacuum dried peels
Moisture (%)	73.97 ± 0.92 [a]	13.76 ± 0.54 [b]	13.78 ± 0.20[b]
Pectin (%)	10.83 ± 0.07[b]	10.63 ± 0.81 [b]	14.93 ± 2.18 [a]
Total phenols as mg gallic acid (GAE/ g)	129.35 ± 1.91[b]	125.34 ± 4.63[b]	151.68 ± 7.93 [a]

The difference in letters in the same row demonstrates a significant difference at P< 0.05.

found in the present study. Katharine *et al*. (2021) indicated that the pectin composes 6.8-10.1% w/w of pomegranate rind. Generally, the pectin content of pomegranates depends on so many factors. Many commercial pectin preparations have been used in various food products for their marvelous effects, as agents for forming gels, emulsifiers, give thickening, improving colour and as stabilizes

Total phenols: The results given in Table (1) show that the total phenolic content of the methanol extracts for fresh, hot air oven and under-vacuum dried pomegranate peels was 129.35, 125.34 and 151.68 mg gallic acid equivalent/ g dry matter, respectively. The methanol extract of under vacuum dried pomegranate peel powder gave higher total phenolic content, compared with hot air oven dried and fresh pomegranate peels. Sinir *et al*. (2019) found that the drying methods resulted in variable total phenols content. The highest total phenolic content of *Citrus japonica* was attained by vacuum drying, which allows slight degradation of the phenolic compounds as compared with the hot air drying methods.

Pomegranate peels which represent from 26 to 30% of the fruit weight, are found to contain an interior complex net of membranes, which are comprised by specified phenolic compounds, Ismail *et al*. (2012). Those phenols are of so many important phytochemicals for their effects as an antioxidant, chelating power for active fractions of redox metals, inactivating lipid free radicals, and are good indicator for assessing the antioxidant capacity in preliminary screening for any natural product or compound planned for use as an antioxidant in formulated food products according to Abdel Wahab *et al*. (2016).

Dietary fiber: Dietary fiber (DF) is that part of plant origin in the diet which resists the digestive enzymatic effect through digestion. The DF includes many complex polysaccharides cellulose, hemicellulose, pectic substances, gums, mucilage and a non-carbohydrate component lignin according to Mahmoud *et al*. (2015) and El-Habashy (2017). The DF is present mainly in cereals and their products, as well as vegetables and fruit products. As shown in Table (2), neutral detergent fibers (NDF) were 15.79 % and 12.28% in hot air oven and under vacuum dried peels powder, respectively. The NDF represents the cell wall that includes lignin as well as cellulose and hemicellulose. Acid detergent fibers (ADF) are an indication of the presence of cellulose and lignin. The ADF content was 9.05 % and 6.62 % in hot air oven and under vacuum dried peels powder, respectively. The difference between NDF and ADF gives the insoluble hemicellulose. Hemicellulose content was 6.75 % and 5.67 % in hot air oven and under vacuum dried peels powder, respectively. Acid detergent lignin content was measured and gave 2.35 % and 1.61 % in hot air oven and under vacuum dried peels powder, respectively. Cellulose content which is the difference between ADF and ADL as shown in Table (2) is found to be 6.69% and 5.01% in hot air oven and under vacuum dried peels powder, respectively.

The present results showed that NDF, ADF, ADL, hemi- cellulose and cellulose increased in hot air oven dried peels compared with under vacuum dried peels. Urganci & Isik, (2021) found that the total DFcontent of air oven dried pomegranate peels was 43.49%, while soluble dietary fiber (SDF) and insoluble dietary fiber IDF was 8.15% and 35.34 %, respectively.

Table 2: Dietary fiber contents of pomegranate peels (on dry weight basis)

Treatment / Component (%)	Hot air oven dried peels	Under vacuum dried peels
Neutral detergent fiber (NDF)	15.79	12.28
Acid detergent fiber (ADF)	9.05	6.62
Acid detergent lignin (ADL)	2.35	1.61
Cellulose	6.69	5.01
Hemi-cellulose	6.75	5.67

The SDF (prebiotic) include pectin, oligosaccharides, and gums are water soluble and are fermented in the digestive tract, while IDF, namely, hemicellulose, cellulose and lignin are not affected by the body enzymes. Various food fiber has many beneficial effects as regulating intestinal function, improving tolerance to glucose, in the case of diabetes, and showing anti-carcinogenic effects, through the adsorption of some of the carcinogenic constituents. The U.S. Food and Drug Administration (FDA), recommended the DF daily intake of adults to be 25 g in a diet containing 2000 kcal.

Total ash and minerals content: The ash content of fresh, hot air oven and under vacuum dried pomegranate peels as shown in Table (3) was 4.65%, 5.36% and 5.82%, respectively. Sorour *et al*. (2014) showed that the ash content of fresh

Table 3: Ash (%) and minerals content (mg/100 g) of pomegranate peels (on dry weight basis).

Component \ Treatment	Fresh peels	Hot air oven dried peels	Under vacuum dried peels
Ash	4.65± 0.08[c]	5.36± 0.05 [b]	5.82 ± 0.04 [a]
Minerals Calcium (Ca)	148	204.492	225.768
Iron (Fe)	3	4.573	2.318
Zinc (Zn)	1	1.289	0.612
Manganese (Mn)	0.4	0.535	0.844
Phosphor (P)	100	107.398	105.115
Potassium (K)	1570	1457.105	1466.319
Sodium (Na)	300	144.908	129.645

The difference in letters in the same row demonstrates a significant difference at $P< 0.05$.

pomegranate peels was 8.1%, while the ash content of dried pomegranate peels dried reached 5.5%. Generally, the ash content of plant materials is affected mainly by their mineral components. The daily requirement of the main minerals, namely Na, K, Ca, Mg and P, exceeded 100 mg, representing 1 % of the human body weight, while trace minerals such as Mn, Fe, Cu and Zn make up less than 0.01 % of the body weight and are essential in markedly small amount according to Fawole & Opara, (2012).

Seven elements namely, calcium (Ca), iron (Fe), zinc (Zn), manganous (Mn), phosphorous (P), potassium (K) and sodium (Na) were determined in fresh and dried pomegranate peels, (Table 3). The K content was the highest, followed by Na, Ca, P, Fe, Zn and Mn. The results also show that potassium and sodium content decreased by both of the dehydration methods as compared with the fresh peels. According to Rowayshed *et al*. (2013), and Mahmoud *et al*. (2015), the level of components varies due to the method of drying and the sensitivity of the components to heat during the process.

Minerals are very essential for the biochemical function processes of the body. Sodium and potassium play an essential role in the transport of some metabolites, and has a proved marked effect on blood pressure. The Na/K ratio in the diet is of great importance for hypertension arteriosclerosis, as K shows a depressing effect while Na has an increasing effect on blood pressure. The recommended adult daily intake is 3000 mg of potassium. Also, phosphorus (P) is an essential mineral as its deficiency represents a health hazard. P/Ca must be balanced with vitamin D according to Abdel Wahab *et al*. (2016). Iron (Fe) is essentially necessary for hemoglobin structure, oxygen transfer, functional processes of the central nervous system, and oxidation of metabolites. Zinc and manganese are essential micro elements of growth and immune functions, and many physiological processes, being constituent and activating factors of some enzymes according to Ullah *et al*. (2012).

Pectin and phenols extraction: Extraction of pectin from plant materials can be carried out by various chemical and physical methods along with some enzymatic treatments. Acid extraction used to be the most widely method applied commercially for pectin production. Pectin extraction is a multiple hydrolysis process of protopectin and other pectin macromolecules to help in their solubility into the extraction solvent according to the other adjusted extraction condition, namely, temperature, pH and time. The results of pectin extraction methods from different pomegranate peels are shown in Table (4). The yield of pectin by the hydrochloric acid method gave significantly higher pectin yield (10.96%), compared with the hydrothermal method (4.49 %), and the sonication-free cellulase treatment (5.54%). The total phenolic content was determined in the aqueous-ethanolic extract resulting from pectin removal by centrifugation. It was estimated as 108.59, 87.13 and 51.41 mg gallic acid equivalent / g dry matter for hot air oven dried, fresh and under vacuum dried pomegranate peels, respectively as presented in Table (4).

Pectin is easily extracted in hot acidified water. Yet, the extraction of pectin with mineral acids has many drawbacks , of it as the loss of some volatiles, high costs, and impaired environmental effects , as well as the degradation and loss of other valuable important phytochemicals t compounds found in the used plant materials. Recently other optimizing cleaner extraction techniques for effective extraction methods of pectin are suggested. That is by using enzyme, microwave, ultrasound, water and electric field pectin extraction according to Panouille *et al*. (2006), Adetunji *et al*. (2017) and Dranca & Oraian, (2018).

Table 4: Effect of extraction methods on the amount of pectin and total polyphenols extracted from PPP

Component \ Treatment	Hydrochloric acid Extraction	Hydrothermal extraction	Sonication (probe) and free cellulase extraction
Pectin (%)	10.96 ± 1.5 [a]	4.49 ± 1.24 [b]	5.54 ± 0.81[ab]
Total phenolic content (mg GAE/ g)	108.59 ± 2.27[a]	87.14 +10.45 [b]	51.42 ± 1.87 [c]

The difference in letters in the same row demonstrates a significant difference at $P< 0.05$.

Ultrasound use either bath or probe units cause cavitation due to the continuous process of expansion followed by compression. This process of ultrasound-assisted extraction (UAE) using probe units is generally applied in a small laboratory experiments. Focusing ultrasonic energy on specific part of the extracted sample resulted in more cavitation, with more effective extraction and yield. That is according to the adjusted conditions of time, temperature, energy, and frequency of sonication. According to Moorthy *et al*. (2015) pectin extracted by UAE from pomegranate peels gave a yield of 4.2 - 24.2%, depending on the extraction conditions. The UAE is an environment friendly means, along with saving cost and energy according to Maric *et al*. (2018).

Colour: Colour measurements reported as lightness value (L*), redness value (a*) and yellowness value (b*) of different pomegranate peels are shown in Table (5). The fresh pomegranate peels had higher a* values (16.43) than under vacuum dried peels (14.14) and hot air oven dried peels (9.42), while they had lower L* value (41.27) than hot air oven dried peels (56.07) and under vacuum dried peels (57.75). Colour a* value could be linked to the water soluble anthocyanin pigment, which provides the natural pink, red and purple colour of pomegranate peels according to Kandylis & Kokkinomagoulos, (2020) and Urganci & Isik,(2021). These pigments have numerous effective health benefits .They play a role as antioxidants, protect against inflammatory effects, and have numerous actions in preventing diseases. Flavonoids, anthocyanins and phenolic acids, are mainly found in the fruit peel according to Magangana *et al*. (2020). Table (5) also shows that hot air oven dried peels had higher b* value (22.39) than under vacuum dried peels (21.77) and fresh peels (15.93). Colour b* indicating yellowness is due to the carotenoids according to Urganci & Isik (2021).

Table 5: Colour values of pomegranate peels.

Colour value \ Treatment	Fresh peels	Hot air oven dried peels	Under vacuum dried peels
Lightness L*	41.27	56.07	57.75
Redness a*	16.43	9.42	14.14
Yellowness b*	15.93	22.39	21.77
Δ E	62.456	49.6579	49.0478

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(a) (b) (c)

Fig. 1: Fresh pomegranate peel (a), hot air oven dried (b) and under-vacuum dried pomegranate peel powder (c).

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مسحوق قشور الرمان كمكون واعد فى تطبيق التكنولوجيا الخضراء"

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استخدم فى الدراسة قشور ثمرة الرمان بعد إزالة الحبات التي تحتوي العصير والبذور. تمثل مخلفات الرمان على المستوى العالمي ١,٦٢ مليون طناً. مثل تلك المخلفات لها أثر سلبي ضار بالبيئة، كما يسهم في التغيرات المناخية من خلال انبعاث غاز الميثان. استهدفت الدراسة الوقوف على المكونات الحيوية والتغذوية الهامة في مخلفات قشور الرمان بهدف الاستفادة منها لما لها من أهمية في الحد من مخلفات التصنيع. تم تجفيف قشورالرمان بفرن الهواء الساخن أو تحت التفريغ والحصول على مسحوق القشور الذي يحتوي على ١٠,٩ و١٤,٩٪ بكتين، محتوى فينولات كلي ١٢٥ و١٥١,٧ مجم/جم كحامض جاليك على الترتيب في مسحوق القشور المجفف بالهواء الساخن وتحت التفريغ. احتوى مسحوق القشور على قدر من الألياف الغذائية بأنواعها المختلفة وعلى محتوى العناصر المعدنية. اتضح أن مسحوق قشور الرمان غني في محتواه من البوتاسيوم ويليه الصوديوم، الكالسيوم، الفوسفور بالاضافة إلى وجود كم أقل من الحديد، الزنك، المنجنيز.

تم إختبار ومقارنة ثلاث طرق لاستخلاص البكتين والمركبات الفينولية وهي طريقة الاستخلاص بحامض الهيدروكلوريك، طريقة الاستخلاص الحراري المائي، الطريقة الحديثة بالموجات فوق الصوتية مع وجود إنزيم السيليوليز. تراوح عائد البكتين بين ٤,٥ إلى ١١,٠٪ وعائد المركبات الفينولية بين ٥١,٤ إلى ١٠٨,٦مجم/جم كحامض جاليك. أعطت طريقة الاستخلاص بالحامض العائد الأعلى لكل من البكتين والمركبات الفينولية. بشكل عام فإن الطرق الثلاث تعتبر ذات عائد منخفض، مكلفة، مستهلكة للطاقة والوقت، ملوثة للبيئة بما ينجم عنها من أحماض وكحولات يتم التخلص منها بكميات كبيرة.

الخلاصة أظهرت النتائج أن تجفيف قشور الرمان سواء بالهواء الساخن أو تحت التفريغ ما أمكن ذلك يعتبر من تطبيقات التكنولوجيا الخضراء للحد من التلوث البيئي الناجم عن تصنيع العديد من منتجات الرمان. التجفيف يزيد من القدرة الحفظية للمخلفات. يمكن بذلك الحصول على مكون غني بالمواد بالمركبات الحيوية الوظيفية والمعادن الأساسية مع تميز المسحوق بلون برتقالي مقبول بما يمكن من استخدامه في إعداد خلطات لمنتجات غذائية وظيفية.