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Nutritional composition of fresh pomegranate peel powder

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Abstract

Pomegranate (*Punica granatum* L.) is an ancient favorite table-fruit of the tropical and subtropical regions of the world, belonging to the family Punicaceae. Bhagwa variety among all the varieties grown in India is easily available on commercial scale. Fruits and vegetable processing in India generates substantial quantities of waste and these wastes of fruits are an abundant source of antioxidant and polyphenols among those pomegranate peel, a byproduct of juice processing industries was reported to contain a series of bioactive compounds (tannins, flavonoids and other phenolic compounds), minerals and fibres for a wide range of dietary requirements. The present study is undertaken to know the nutritional importance of fresh pomegranate peel powder. Fresh pomegranate peel collected after juice extraction from Bhagwa variety of pomegranate, fresh peels were cut into small pieces and pretreated with 2% salt solution, after pretreatment fresh peels were placed in tray drier to obtain dried peel then dried peels were crushed by food grinder to obtain powder.

Keywords: Pomegranate peel powder (PPP), Gallic acid equivalent (GAE), nutritional value

Introduction

Pomegranate (*Punica granatum* L.) is an ancient favorite table-fruit of the tropical and subtropical regions of the world, belonging to the family Punicaceae. India is the world leading country in pomegranate production is 13.45 lakh tones from an area of 1.93 lakh hectares with a productivity of 11.39 tonnes/ha (NHB data base). Bhagwa variety among all the varieties grown in India is easily available on commercial scale. Pomegranate peels are characterized by an interior network of membranes comprising almost 26-30 per cent of the total fruit weight and are characterized by substantial amounts of phenolic compounds, including flavonoids (anthocyanins, catechins, and other complex flavonoids) and hydrolyzable tannins (punicalin, pedunculagin, punicalagin, galic and ellagic acid). These compounds are concentrated in pomegranate peel and juice which account for 92 per cent of the antioxidant activity associated with the fruit. Gallic acid, ellagic acid and punicalagin, in addition to their free radical scavenging properties, also possess antibacterial activities against intestinal flora, particularly enteric pathogens i.e., *Escherichia coli*, *Salmonella spp.*, *Shigella spp.*, as well as *Vibrio cholera* (Negi *et al.*, 2003) [10].

Pomegranate peel attracts attention due to its apparent wound healing properties (Chidambara *et al.*, 2004) [4], immune modulatory activity and antibacterial activity antiatherosclerotic and antioxidative capacities (Tzulker *et al.*, 2007) [17]. Antioxidative activity has often been associated with a decreased risk of various diseases (Whitley *et al.*, 2003) [20] as well as pomegranate peel is rich source of ellagitannin (antioxidant) and thus may serve in the prevention of cattle diseases and improvement of beef products making it an attractive component in cattle feed. Recent studies also have shown that boosting antioxidant levels in the diet of cattle may help to improve their health. The peel packs some of the weight boosting and health enhancing effects of antibiotics and hormones without the detrimental effects and it may yield meat with higher level of beneficial antioxidants (Shabtay *et al.*, 2008) [16].

Pomegranate peel and its extracts are also being investigated for their potential uses as food biopreservatives, formulation of products in nutraceutical industry, for preparation of value added products and cattle feed (N. Seeram *et al.*, 2005). The present study is undertaken to know the nutritional importance of fresh pomegranate peel, a byproduct of pomegranate juice industry.

Materials and methods

Production of pomegranate peel powder:

Separation of peel

Pomegranate fruits harvested at optimum maturity and with good colour were brought to Department of Post-Harvest technology, Bagalkot. Fruits after thorough washing in tap water cut into four parts by clean stainless steel knife and then peel and seeds were separated manually without damaging. The peel obtained was used for further usage.

Pre-treatment

After separation of peel and other waste parts, the peel was cut into pieces by using stainless steel knife and then pre-treated with 2% salt solution for 10 minutes, drained off salt water then washed again with tap water and drained off water peels were spread on stainless steel tray and dried under ceiling fan to remove surface water. These peels were taken for drying (Kushwaha *et al.*, 2013) [7].

Process of dehydration to get the pomegranate peel powder

After pretreatment, fresh pomegranate peel was placed in a tray drier at 65 °C for 10 hr to obtain dried peel. The dried pomegranate peel was crushed by food grinder in to powder form to completely pass through 0.5 mm size sieve. Pomegranate peel powder was packed in HDPE for further Physico chemical analysis and for fortification in various food products preparation.

Physical analysis

Peel weight (g): After separation of arils from 1kg of fruits, peel of the fruit was weighed and expressed in grams.

Weight of arils (g): Arils present in 1kg pomegranate fruits were weighed and expressed in grams.

Waste index (%): Waste index in pomegranate was estimated by using the formula.

$$\text{Waste index in pomegranate} = \frac{\text{Weight of fruit (g)} - \text{Weight of juice (g)}}{\text{Weight of fruit (g)}} \times 100$$

Sensory evaluation

The fresh peel powder was analyzed for sensory evaluation with respect to colour, odour and appearance.

Chemical analysis

Moisture (%): Moisture content was measured by slightly modifying the hot air oven method (Anon, 1995). Empty stainless steel moisture dishes with lids were first dried into a pre-heated oven (100 ± 1°C) for 1 h. The dishes and lids were then cooled for 30 min in a desiccator. Approximately 10 g of pomegranate peel powder were accurately weighed into the pre-weighed dishes and placed into the oven with the lids placed under the respective dishes. These samples were dried at 105°C for 3 h and cooled in a desiccator for 30 min. The process of drying, cooling and weighing was repeated until constant weight obtained. Results were calculated in percentage using the following equation:

$$\text{Moisture content (\%)} = \frac{W_1 - W_2}{\text{Weight of the sample}} \times 100$$

Where:

W_1 = Weight of the moisture cup and sample before heating

W_2 = Weight of the moisture cup and sample after heating

Protein (%)

Determination of protein content was carried out by micro kjeldhal method which consists of wet digestion, distillation and titration. The protein content was determined by weighing 0.2g of pomegranate peel powder and transfer to a 250 ml Kjeldahl flask, care to see that no portion of the sample clings to the neck of the flask. To this 1 to 2 g of catalyst mixture (potassium sulphate 100 g and copper sulphate 20 g) and 10 ml of concentrated H₂SO₄ was added. Flask was placed on the stand in the digestion chamber and continue the process of digestion until the colour of the digest is pale green. The digestion mixture was cooled by adding 30 ml of water. After digestion, distillation was carried out by using 40% NaOH and 20% boric acid using methyl orange as an indicator and titrated against 0.1 N H₂SO₄. The protein content was calculated as follows:

$$\text{Nitrogen (\%)} = \frac{14.01 \times \text{ml titrate value of sample} \times \text{N of H}_2\text{SO}_4 \times 100}{\text{Sample weight (g)} \times 1000}$$

Protein content was obtained by converting nitrogen to protein by using conversion factor of 6.25

$$\text{Protein (\%)} = 6.25 \times \text{Nitrogen (\%)}$$

Ash (%)

Total ash content was determined by burning the nutri-enriched cookies in pre-weighed crucible in a muffle furnace at 500°C for 6 hours (Rao and Bingren, 2009). After burning the residue ash weight was recorded and ash content was calculated by using the formula.

$$\text{Total ash (\%)} = \frac{\text{Weight of the ash (g)}}{\text{Weight of the sample (g)}} \times 100$$

Crude fibre (%)

Crude fibre estimation was done by using Fibra plus-FES-6 instrument. About 1g of the sample was weighed in the crucibles, fixed to the fibraplus instrument and then 100 ml of 1.25% H₂SO₄ was added to all the samples by closing the knobs. The temperature was set to 370°C and leave the sample for 40 minutes. After 40 minutes, the temperature was reduced to 200°C and open the knobs to remove all H₂SO₄ by suctioning and washed with distilled water and distilled water was removed by suctioning. The same procedure was repeated by adding 100 ml of 1.25% NaOH to all the samples. Then crucibles were taken and kept in an oven at 100°C for 3 hours and the crucibles were cooled in desiccator and weight was taken (W_1). After weighing, crucibles were kept in a muffle furnace at 500°C for 1 hour, allowed to cool and reweighed (W_2). Per cent of crude fibre in nutri-enriched cookies was calculated by using the following formula:

$$\text{Crude fibre (\%)} = \frac{W_1 \text{ (g)} - W_2 \text{ (g)}}{\text{Weight of the sample (g)}} \times 100$$

Where,

W_1 = Weight of crucibles after drying in an oven

W_2 = Weight of crucibles after ashing in muffle furnace

Fat content (%)

Fat content was determined by using the Socs plus-SCS-6AS instrumentas described by Ojure and Quadri (2012). Initially weight of the beaker was taken (initial weight) and two grams of the powdered nutri-enriched cookies were taken in thimbles and thimbles were placed in thimble holder and the thimble holder was kept in a beaker and to this 80 ml petroleum ether was added. The fat extraction process was carried out for 45 minutes by setting the temperature at 90°C. After 40 minutes, the beakers were kept in an oven at 100°C for 10-15 minutes to evaporate the petroleum ether. The beakers were then cooled in a desiccator and weighed again (final weight). The fat content was calculated using the following formula:

$$\text{Fat content (\%)} = \frac{\text{Final Weight (g)} - \text{Initial weight (g)}}{\text{Weight of the sample (g)}} \times 100$$

Carbohydrate (%)

Carbohydrate content was calculated by differential method (Anon, 1980).

Carbohydrate (g/100 g) = 100 - [Protein (%) + Fat (%) + Ash (%) + fibre (%) + Moisture (%)].

Calorific value (Kcal /100 g)

Energy was calculated by differential method (Anon, 1980).

Energy (K.cal) = [Protein (g) x 4 + Fat (g) x 9 + Carbohydrates (g) x 4]

Water activity

Water activity of nutri enriched cookies fortified with pomegranate peel powder and defatted soybean flour was determined by water activity meter (Labswift-a novasina).

Total phenol content (mg GAE/g)

Total phenol content of samples was estimated by Folin Ciocalteu reagent (FCR) method and expressed as mg Gallic acid equivalent (GAE) per 100 ml.

A sample of 0.5 ml was taken and 10 ml of ethanol was added and filtered the solution using filter paper from which one ml filtered solution was taken in a test tube and boiled at 100°C till the solution was evaporated. One ml of distilled water was added to the test tube and from this, 0.5 ml solution was taken into another test tube to which 2.5 ml of distilled water, 1 ml of FCR reagent and 2 ml of sodium carbonate was added, cooled and finally absorbance was measured at 650 nm by using spectrophotometer. Total phenol content was calculated with the help of standard graph and expressed in mg GAE per 100 ml of sample (Sadasivam and Manickam, 2005) [15].

Antioxidant activity (%)

The percentage of 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity of the pomegranate peel powder and soybean fortified cookies was determined by a method of Egdhami Asli. (2010) [5]. Sample (0.1ml) or 0.1ml of methanol (control) mixed with 3.9 ml of 25mg/l methanolic solution of DPPH and methanol used as blank. The mixture was vortexed thoroughly for 1min and left at 37 °C temperature for 30 minutes in darkness and then the spectrophotometer absorbance was read against blank at 517nm (Model: UV Spectrophotometer, Spectronic® Genesys™ 2 instruments, USA). DPPH free radical scavenging ability (%) was calculated by using the formula: (A 517nm of control – A 517nm of samples/A 517 nm of control) × 100

Minerals

Mineral estimation was done by wet digestion, it involves oxidizing acids like HNO₃: H₂SO₄: HClO₄ tri-acid mixture or HNO₃: HClO₄ Di- acid mixture. Per chloric acid on heating dissociates into nascent chlorine and oxygen, increasing the oxidation efficiency at high temperature. Sample (0.5g) was taken into 100 ml conical flask and 5 ml of nitric acid was added. After pre digestion, it was heated at 180- 200°C temperature, cooled and 15 ml of di-acid mixture was added again and heated at 180-200°C on hot plate until the content was turned to brown colour. To this, 50 ml of water was added and filtered into 100 ml volumetric flask by using What's man No.1 filter paper, this filtrate was used for mineral estimation by " Micro-Wave Plasma Atomic Emission Spectrometer " instrument. Calcium was determined by titration method (Piper, 1966) [12].

Colour (L* a* b*)

Cookies colour was measured with a ColorFlex EZ (Model CFEZ 1919, Hunter Associates Laboratory, Inc., Reston) with a 45 mm (diameter) measuring tube using a white tile background. L*, a* and b* values denote lightness (white-black), red-green and yellow-blue scales, respectively. Three colour readings per cookie sample were made. Measurements were made three times, each at a different location on the consistent (same) side of the surface of the cookies. There were three replicate cookie samples for each treatment.

Table 1: Physical observation of fresh pomegranate peel powder

Parameters	Fresh peel powder
Color	Dark brown color
Odour	Characteristic with tannin odour
Appearance	Dark brown colored fine powder

Table 2: Minerals content (mg/100g dry matter) of pomegranate peel powder

Mineral (mg/100g)	Pomegranate peel powder
Calcium (Ca)	342
Magnesium (Mg)	-
Potassium (K)	148.64
Sodium (Na)	64.63
Phosphorous (P)	118.30
Iron (Fe)	6.35
Zinc Zn	0.93
Manganese (Mn)	0.78
Copper (Cu)	0.64

Minerals Content of Produced Pomegranate peel powder:

The nutritional quality of pomegranate peel powder (PPP) with regards their minerals content was evaluated and the obtained results are recorded as in Table (2). From the obtained data (Table 2), it could be showed that the pomegranate fruits peel powder (PPP) contained all tested minerals, with the exception of Mg which was not detected in them. The PPP contained the most determined minerals at adequate concentration and the predominant minerals in it were found to be Ca, K, P and Na at level of 342, 148.64, 118.30 and 64.63 mg/100g dry matter; respectively. In addition, the PPP contained a considerable content of Fe, Zn, Mn and Cu at level of 6.35, 0.93, 0.78 and 0.64 mg/100g dry matter; respectively. In general, it could be concluded that pomegranate fruits peel powder was characterized with their richness with the most determined nutritious minerals and they are considered a good source of macro and micro

elements. Therefore, they should be utilized in food fortification.

Table 3: Chemical Composition of Fresh Pomegranate Peel Powder

Nutrients	Pomegranate peel powder (PPP) *
Moisture (%)	7.27
Protein (%)	3.74
Ash (%)	4.32
Crude fibre (%)	17.31
Fat (%)	0.85
Total phenol content (GAE mg/g)	18.75
Antioxidant activity (%)	59.64
Water activity (a_w)	0.28
L^*	64.36
a^*	7.38
b^*	30.64
Carbohydrate (%)	66.51

The Nutrient composition of fresh pomegranate peel powder (PPP) is presented in Table 1. The moisture content, ash, protein, total fat and carbohydrate of PPP were 7.27, 4.32, 3.74, 0.85, and 66.51 per cent, respectively. Antioxidant activity was 59.64% with colour value of L^* (64.36), a^* (7.38) and b^* (30.64). Total phenol content, water activity and crude fibre were 18.75 mg GAE/g, 0.28 and 17.31 per cent, respectively. The similar results were reported by Ismail *et al.* (2014) [6]; Rowayshed *et al.* (2013) [14]; Kushwaha *et al.*, (2013) [7] observed that pomegranate fruits peel contains moisture (13.7%) and in addition, crude protein, crude fat, ash, crude fibre of pomegranate fruits peel powder were 3.10, 1.73, 3.30, and 11.22, per cent, respectively. Total phenol content and antioxidant activity of 27.92 GAE mg/g and 59.64, per cent, respectively were noted in pomegranate peel powder.

In this concern, pomegranate fruits peel can be used as functional ingredient as a good source of crude fibers which provide numerous health benefits such as their ability to decrease serum LDL-Cholesterol level, improve glucose tolerance and the insulin response, reduce hyperlipidemia and hypertension, contribute to gastrointestinal health and the prevention of certain cancers such as colon cancer (Lansky & Newman, 2007 and Viuda-Martos *et al.*, 2010 a,b) [19]. On the other hand, fruits' fibers can be considered as potential ingredients of foods; especially of meat products because of their ability to reduce the residual nitrite level, thus avoiding the possible formation of nitrosamines and nitrosamides (Viuda-Martos *et al.*, 2009 b) [18] and they have been used in meat products processing as fat replacer, reducing agent of fat absorption during frying, volume enhancer, binder, bulking agent and stabilizer.

Aqueous suspension of pomegranate peel powder has shown good anti-oxidant activity evaluated by DPPH radical scavenging method. Phenolic content of pomegranate peel are responsible for potent antioxidant activity. Crude extracts and purified fraction from pomegranate peels could provide health benefits to humans and may be employed in food preservation and pharmaceutical purposes.

Conclusion

From above comparative results and discussion of fresh pomegranate peel powder it can be concluded that pomegranate peel i.e. Fruit juice industrial waste can be further fortified in preparation of various products at very low cost. Although fresh peel powder also exhibit higher amount of nutritional component except few components but it was

found that its higher phenol content and antioxidant activity as well as good source of crude fibre which provide numerous health benefits such as their ability to decrease serum LDL-Cholesterol level, improve glucose tolerance and the insulin response, reduce hyperlipidemia and hypertension, contribute to gastrointestinal health and the prevention of certain cancers such as colon cancer. Pomegranate fruit peels are by products of the food industry. Value added products could be made from those wastes.

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