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Development of freeze dried pomegranate peel powder and acceptability of formulated tea

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ABSTRACT

Pomegranate (*Punica granatum* L.) peel is a nutritive, antioxidant rich by-product, easily available after production of pomegranate juice. The study aimed to develop a freeze- dried pomegranate peel powder, identify its physico-chemical properties, formulate tea and evaluate the sensory attributes. Red pomegranate peels were freeze dried and ground to a fine powder. The freeze dried pomegranate peel powder and a randomly selected commercial tea powder were analysed for physico-chemical properties, functional properties, nutrient composition, phenolic constituents, and sensory analysis. Samples weighing 2 grams , 3 grams and 5 grams each of the pomegranate peel powder and commercial tea powder were added to 125 ml of purified water and allowed to boil for the extraction of essence . The tea samples were subjected for sensory evaluation by thirty semi trained panel members. The moisture, ash, pH, titratable acidity, water absorption capacity, oil absorption capacity and swelling power were found to be higher in the pomegranate peel powder. Total polyphenol content, tannins and free radical scavenging ability were high in pomegranate peel powder. Pomegranate peel powder had a better nutritional composition and phenolic constituents compared to the commercial tea powder and exhibited good antioxidant properties.

Key Words : Pomegranate, Peel, Freeze dried, Peel powder, Polyphenols, Pomegranate peel tea

INTRODUCTION

A large number of epidemiological studies have consistently shown that dietary habit is one of the most important determinants of chronic degenerative diseases In the past few years demand for food products containing bioactive compounds as well as non-food products *i.e.* dietetics and pharmaceuticals has increased. These products which have incorporated phytochemical enriched extracts or food extracts have beneficial physiological effects on human health (Nivya and Raja, 2012).

According to Bahadoran and Mirmiran (2013) polyphenols are natural phytochemical compounds in plant-based foods, such as fruits, vegetables, whole grains, cereal, legumes, tea, coffee, wine and cocoa; more than 8000 polyphenolic compounds, including phenolic acids, flavonoids, stilbenes, lignans and polymeric lignans have been identified in whole plant

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foods (Pandey and Verma, 2010).

Pomegranate (*Punica granatum* L.) peel is a nutritive, antioxidant rich by-product, easily available after production of pomegranate juice and ready to eat arils (Sayed-Ahmed, 2014). Pomegranate is listed as a medicinal herb in Ayurvedic Pharmacopoeia of India. Fifty per cent of the total fruits weight corresponds to total peel which is an important source of bioactive compounds such as phenols, flavonoids, ellagitannins and proanthocyanidin compounds that acted more dramatically against oxidation as compared to the pulp extract (Li and Guo, 2006). The health benefits of pomegranate peel are accredited for the pharmacological activities exhibited by bioactive phytochemicals like polyphenols (Al-Rawahi and Edwards, 2014).

In recent years, more medicinal values of pomegranate peel have been investigated such as abortifacient, analgesic, antiameobic, antibacterial, anticonvulsant, antifungal, antimalarial, anti-mutagenic, antiviral, antispasmodic, diuretic, hypoglycemic, hypothermic, and antioxidant activities (Seeram *et al.*, 2006).

With this in view, the present study was conducted to develop a freeze- dried pomegranate peel powder, identify its physico-chemical properties , nutrient content and phenolic constituents, formulate tea from the developed pomegranate peel powder and evaluate the organoleptic properties of the pomegranate peel tea.

METHODOLOGY

The drying method significantly reduced the total phenols in pomegranate peels except the freeze drying which retained the highest phenolic content when compared to other drying methods (43.9mg/GAE/g dry solids) (Al-Rawahi and Edwards, 2014). Therefore, the investigator selected freeze-drying as a method for drying the pomegranate peels.

Red pomegranates were purchased from the local fruit shop, washed with purified drinking water, dried and cut into small thin pieces. The peels were weighed in an electronic weighing balance and it was found to be 202.36 grams before drying. The peels were then transferred to a 500 ml glass beaker. The mouth of the beaker was covered with aluminum foil and tightly tied with the rubber band further drying was carried out in the Central Instrumentation Laboratory, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore. The beakers were kept in the deep freezer overnight at a temperature of – 35 ºC. The beakers were then transferred to the freeze dryer and dried at -45 ºC. This process was repeated continued for four days to get freeze dried pomegranate peels. The freeze dried peels were then weighed and the weight was found to be 65.08 grams. The peels were then ground to a fine powder in a food mixer. The contents were then transferred to a zip lock pouch and stored in a cool dry place.

Black tea is the most common type of tea outside of Asia being the most versatile in usage (Piovan and Filippini, 2014). Hence, a commercial tea powder was randomly selected and purchased from a local grocery store for the study, and transferred to a zip lock pouch and stored in a cool dry place for comparative analysis.

Standardization of pomegranate peel tea and commercial tea :

The formulated tea samples and the commercial tea samples containing 100ml each of

commercial tea and pomegranate peel tea was found to be bitter and the other formulations containing 150, 200, and 250 ml of water was found to be diluted and bland. Therefore the recipe was standardized using a standard tea cup. The volume of the standard tea glasses was measured with water which was found to be 125 ml. On this basis, 125 ml of purified water was taken in six tea pans and heated till it reached the boiling point. Then the samples weighing 2 grams 3 grams and 5 grams each of the pomegranate peel powder and commercial tea powder was added to it and allowed to boil for two minutes. After boiling, the infusion was allowed to steep for two minutes for the extraction of essence and transferred to glass tea cups. The tea samples were subjected for sensory analysis and it was found to be acceptable by the panel members. Sugar was added to another sample of the formulated tea and analysed. The proportion of the ingredients are shown in Table 1.

Table 1 : Proportion of ingredients in the formulation of pomegranate peel tea and commercial tea

Ingredients	Variation 1	Variation 2	Variation 3
Commercial tea powder (g)	2	3	5
Pomegranate peel powder (g)	2	3	5
Water (ml)	125	125	125

Thirty semi-trained panel members were selected based on their health, cooperation, willingness and knowledge of quality characteristics and sensory analysis of foods. 125 ml of tea containing two, three and five grams of commercial tea powder and pomegranate peel powder were served with and without sugar for the acceptability test. The sensory analysis was carried out in the Food laboratory of the Department of Food Science and Nutrition, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore

A score card using a five point scale was used for studying the most acceptable form of tea in terms of colour, aroma, flavor, after taste, astringency, overall acceptability.

RESULTS AND DISCUSSION

Physico-chemical properties of pomegranate peel powder and commercial tea powder.

Physicochemical properties of the pomegranate peel powder and commercial tea powder are given in Table 2.

The findings of the study indicated that the moisture content was 3.8 per cent in the pomegranate peel powder while for the commercial tea powder it was 2.5 per cent. It was observed that the moisture content of the pomegranate peel powder was higher than the commercial tea powder. Studies indicated that freeze dried products rapidly rehydrate and

Table 2 : Physico- chemical properties of pomegranate peel powder and commercial tea powder

Parameters	Pomegranate peel powder	Commercial tea powder
Moisture (%)	3.8	2.5
Ash (g)	5.8	4.5
pH	3.6	5.2
Titratable acidity (%)	4.5	6.1

regain water content and organoleptic properties similar to those of the fresh product (Jiang and Zhang, 2010). As per a study conducted by Shishehgarha and Makhlouf, (2002) the reduction of volume during freeze drying is minimal (Serna-Cock and Varga-Munoz, 2015). Hence, it was seen that the freeze dried pomegranate peel powder had higher moisture content due to the hygroscopic nature of the powder.

Ash refers to the inorganic residue remaining after either ignition or complete oxidation of organic matter in food stuff (Kerala Agricultural University, Pineapple Research Station, 2014). The findings indicated that the ash content was found to be 5.8 grams per 100 grams for the pomegranate peel powder and 4.5 grams for the commercial tea powder.

Studies revealed that the ash content is a measure of mineral content of food (Aremu and Oko, 2015). In a study carried out by Sayed- Ahmed *et al.* (2014) it was indicated that the ash content of pomegranate peel powder was found to be 5.5 grams.

The pH is a measure of the product acidity and is a function of the hydrogen ion concentration in the food product (Valero and Carrasco *et al.,* 2012). In this study, the pH value was found to be 3.6 for pomegranate peel powder and 5.2 for commercial tea powder. It is evident from the current findings that the pomegranate peel powder has higher acidity than the commercial tea powder.

The titratable acidity was found to be 4.5 per cent in pomegranate peel powder and 6.1 per cent in commercial tea powder. It is apparent from the research findings that pomegranate peel powder had extreme acidity and commercial tea powder exhibited slight acidity.

Functional properties of the pomegranate peel powder and commercial tea powder:

The functional properties of the pomegranate peel powder and commercial tea powder are presented in Table 3.

From the study, water absorption capacity was found to be 3.5 per cent in the pomegranate peel powder while for the commercial tea powder it was found to be 2.2 per cent. This indicated that the water absorption capacity was higher in the pomegranate peel powder than that of commercial tea powder.

Table 3 : Functional properties of pomegranate peel powder and commercial tea powder

Parameters	Pomegranate peel powder	Commercial tea powder
Water absorption capacity (%)	3.5	2.2
Oil absorption capacity (%)	2.5	1.2
Swelling power (%)	5.6	4.5

Nutrient content of pomegranate peel powder and commercial tea powder :

The nutrient content of the pomegranate peel powder and commercial tea powder are presented in Table 4.

The protein content was found to be 3.13 grams per 100 gram in the pomegranate peel powder while for the commercial tea powder it was found to be 2.0 grams per 100 gram. This indicates that the protein content of pomegranate peel powder is higher than the commercial tea powder. There was a significant difference at the level of 1 per cent between the protein content of pomegranate peel powder and commercial tea powder.

The fat content of the pomegranate peel powder was found to be 9.3 grams, against the

Table 4 : Nutrient content of pomegranate peel powder and commercial tea powder

Nutrients	Pomegranate peel powder (per 100g)	Commercial tea powder (per 100g)	't' values
Protein (g)	3.13 ± 0.03	2.07 ± 0.15	9.68**
Fat (g)	9.33 ± 0.23	1.03 ± 0.15	42.63**
Crude fibre (g)	10.80 ± 0.46	7.80 ± 1.40	2.880*
Iron (mg)	5.60 ± 1.21	0.76 ± 0.46	5.276**
Calcium (mg)	0.13 ± 0.04	0.01 ± 0.001	4.880**
Vitamin C (mg)	10.27 ± 0.25	7.57 ± 0.15	12.97**

Values are mean ± SD of three samples in each group ** - Significant at 1% level, * - Significant at 5% level NS - Not significant

commercial tea powder with 1 gram, which implies that there is a significant difference in the fat content between pomegranate peel powder and commercial tea powder. Hence, it can be observed that there was a significant difference at the level of 1 per cent between the fat content of the pomegranate peel powder and commercial tea powder.

The crude fiber content of the pomegranate peel powder and commercial tea powder was found to be 10.8 grams per 100 grams and 7.8 grams per 100 grams, respectively, depicting a difference at the level of 5 per cent. It is apparent from the results that the crude fiber content is higher in pomegranate peel powder compared to the commercial tea powder.

The iron content was found to be 5.6 mg per 100 gram and 0.76 mg per100 gram in the pomegranate peel powder and commercial tea powder, respectively. It is apparent from the results that the iron content was higher in the pomegranate peel powder than that of the commercial tea powder. There was a significant difference at the level of 1 per cent in the iron content of the pomegranate peel powder and commercial tea powder.

The calcium content was found to be 0.13 mg per 100 grams in pomegranate peel powder and 0.01mg per 100 grams in the commercial tea powder. It was apparent from the results that the calcium content was higher in the pomegranate peel powder with 1per cent significance than that of the commercial tea powder.

The Vitamin C content in pomegranate peel powder was found to be 10.2 mg per 100 grams and 7.8 mg per 100 grams in the pomegranate peel powder and commercial tea powder, respectively. It is implied that the Vitamin C content was higher in the pomegranate peel depicting a significant difference at the level of 1 per cent when compared to the commercial tea powder.

The carbohydrate content was estimated using the differential method. The carbohydrate content was found to be 68 grams per 100grams in pomegranate peel powder and 82 grams per 100 grams in commercial tea powder. The findings revealed that the carbohydrate content of the pomegranate peel powder was higher than the commercial tea powder.

The energy content of the pomegranate peel powder was found to be 368 Kcal per 100 grams and 832 Kcal per 100 grams in commercial tea powder. These findings revealed that the energy is higher in pomegranate peel powder than that of the commercial tea powder.

Qualitative and quantitative assessment of phenolic constituents of pomegranate peel powder extract and commercial tea powder extract :

The qualitative analysis of phenolic constituents in the pomegranate peel powder and

Table 5 : Qualitative assessment of phenolic constituents in pomegranate peel powder extract and commercial tea powder extract

Phenolic constituents	Water		Methanol		Ethanol		Acetone	
	PPP	CTP	PPP	CTP	PPP	CTP	PPP	CTP
Alkaloids	–	+	–	–	–	–	++	+
Terpenoids	–	–	+++	–	+++	–	++	–
Saponins	+++	+++	+	+	+	+	+	+
Flavonoids	+	+	++	+++	++	+++	++	+++
Tannins	+++	+++	+++	+++	+++	+++	+++	+++
Glycosides	+	+	+	+	+	+	+	+
Phenols	+++	+++	+++	+++	+++	+++	+++	+++
Anthraquinones	–	–	–	–	–	–	–	–
Cardiac glycosides	–	–	+++	–	+++	–	+++	–

PPP- Pomegranate peel powder CTP- Commercial Tea Powder
+++ - Appreciable amounts, ++- Moderate levels, 2013 Complete absence

commercial tea powder are presented in Table 5.

The alkaloids were found to be absent in aqueous extract of pomegranate peel powder and it was found to be in trace amounts in commercial tea powder. Except for the acetone extract all the other extracts exhibited total absence of alkaloids in pomegranate peel powder. The acetone and aqueous extract showed trace levels of alkaloids in commercial tea powder.

The terpenoids were present in appreciable amounts in methanol and ethanol extracts of pomegranate peel powder and at moderate levels in the acetone extract. Aqueous extract showed complete absence of terpenoids in the pomegranate peel powder. The terpenoids were completely absent in all the extracts of commercial tea powder.

The saponins were present at appreciable levels in aqueous extract of pomegranate peel powder and commercial tea powder except for the aqueous extract, all other extracts exhibited trace levels of saponins. Flavonoids were present in appreciable amounts in all the extracts of commercial tea powder except for the aqueous extract it was present in trace levels. Tannins were at appreciable amounts in all the extracts of pomegranate peel powder and commercial tea powder. Phenols were present in appreciable amounts in all the extracts of pomegranate peel powder and commercial tea powder. Anthraquinones were completely absent in all the extracts of pomegranate peel powder and commercial tea powder

Cardiac glycosides were completely absent in the aqueous extract of pomegranate peel powder and in appreciable levels in all other extracts. The red ring obtained by Salkowski test indicated the presence of cardiac glycosides. The presence of steroidal ring in the aglycone portion of cardiac glycosides was confirmed by Liebermann Burchart test. These findings showed the presence of terpenoids which are oxidized derivatives of cholesterol. Keller- Killiani test indicated the presence of deoxy sugars in the cardiac glycosides. Further in-depth study can confirm the cardio-protective effect of pomegranate peel powder. The commercial tea powder exhibited complete absence of cardiac glycosides in all the extracts.

Quantitative analysis of phenolic constituents in pomegranate peel powder extract and commercial tea powder extract :

The quantitative assessment of phenolic constituents such as estimation of tannins,

Table 6 : Quantitative assessment of phenolic constituents in pomegranate peel powder extract and commercial tea powder extract

Quantitative parameters	Pomegranate peel powder/100g	Commercial tea powder/100g
Tannins (mg)	211	160
Total Polyphenol Content(mg)	325	211
Total antioxidant activity (µg/ml)	2.4	1.5

total phenolic content, and total antioxidant capacity are presented in Table 6.

The findings of the study indicated that the tannin content was 211 mg per 100 grams in pomegranate peel powder and 160 mg per 100 grams in commercial tea powder. The findings revealed that the total polyphenol content was 325 mg per 100 gram in the pomegranate peel powder and 211 mg per 100 gram in commercial tea powder. It is apparent from the results that the pomegranate peel powder exhibited higher polyphenol contents compared to the commercial tea powder.

In the present study, the antioxidant activity of pomegranate peel powder was found to be 2.4 µg/ml and 1.5 µg/ml in commercial tea powder. It is evident from the results that pomegranate peel powder exhibited highest percentage of inhibition when compared to the commercial tea powder. IC_{50} was calculated for the extract based on the percentage of DPPH radicals scavenged. IC_{50} is defined as the total antioxidant necessary to decrease the initial DPPH radical by 50 per cent.

Assessment of total plate count of pomegranate peel powder and commercial tea powder

The results from the present study shows that the total plate count was higher in the pomegranate peel powder with a value of 9×10^3 colony forming units and 6×10^3 in the commercial tea powder which indicated that the commercial tea powder is more stable than the freeze dried pomegranate peel powder.

Freeze dried products rapidly rehydrate and regain water content and organoleptic properties similar to those of the fresh product (Jiang and Zhang, 2010).

Sensory analysis of the pomegranate peel tea and commercial tea samples :

Tea was prepared using the freeze-dried pomegranate peel powder and it was compared with the standard tea in terms of their organoleptic properties. Both the tea samples were prepared with 2, 3 and 5 grams, and were subjected to sensory evaluation. Table 7 shows the mean scores of tea samples without added sugar and Table 8 shows the mean scores of tea samples with pomegranate peel powder with sugar.

In this study, the overall acceptability and the mean score show that the average scores for all the parameters were higher for the pomegranate peel tea compared to the commercial tea. Studies indicated that freeze dried fruit powders were good in all sensory attribute and also in preserving the nutrient composition (Kumar *et al.*, 2012).

The sensory analysis also revealed that the tea samples containing two grams of pomegranate peel powder and the commercial tea powder was most accepted by the panel members followed by the samples containing three grams of pomegranate peel powder and commercial tea powder. Table 7 and 8 also revealed that the tea samples containing five grams of pomegranate peel powder and commercial tea powder was least accepted by the

Table 7 : Sensory attributes of pomegranate peel tea and commercial tea (Without sugar)

Attributes	2 g/125ml		3 g/125ml		5 g/125ml	
	PPT	CT	PPT	CT	PPT	CT
Colour	3.7	3.1	3.9	3.4	1.9	1.9
Aroma	3.9	3.4	3.9	3.4	2.2	2.0
Flavour	3.9	3.4	3.5	3.0	2.0	1.7
After taste	2.8	2.5	2.0	2.2	1.7	1.7
Astringency	2.2	3.0	2.0	3.0	1.7	1.9
Total	16.5	15.4	16.1	15.8	9.5	9.2
Mean	3.3	3.08	3.22	3.16	1.9	1.84

PPT- pomegranate peel tea, CT- commercial tea

Table 8 : Sensory attributes of pomegranate peel tea and commercial tea (With sugar)

Attributes	2 g		3 g		5 g	
	PPT	CT	PPT	CT	PPT	CT
Colour	3.8	3.5	4.0	3.9	3.7	3.7
Aroma	4.0	3.7	3.8	3.4	3.8	3.1
Flavour	3.6	3.5	3.6	3.9	3.5	3.5
After taste	4.0	3.5	3.9	3.3	3.6	3.2
Astringency	3.9	3.7	3.8	3.3	3.5	3.4
Total	19.3	17.9	19.1	17.8	18.1	16.9
Mean	3.86	3.58	3.82	3.56	3.62	3.38

PPT- Pomegranate Peel Tea, CT- Commercial tea

panel member. Table 8 showed that all the tea samples containing 2, 3 and 5 grams of pomegranate peel powder and commercial tea powder were fairly accepted by the panel members because of added sugar. The pomegranate peel tea sample was highly acceptable when compared to the commercial tea.

The sensory scores presented in Table 7 and 8 revealed that the colour of the pomegranate peel tea was more acceptable than the commercial tea. It is because the commercial tea was black in colour and the pomegranate peel tea had a bright yellow colour. Aroma is one of the critical aspects of tea quality which can determine acceptance or rejection of a tea before it is tasted. (Chaturvedula and Prakash, 2011). The mean scores for aroma presented in Table 7 and 8 reveals that the pomegranate peel tea was highly acceptable compared to the commercial tea. The sensory scores revealed that the pomegranate peel tea was more accepted by the panelists compared to the commercial tea. It is because the mild pomegranate aroma was more preferred by the panel members that the strong aroma of black tea. Therefore it can be concluded that the aroma of the pomegranate peel tea was more acceptable compared to the control sample.

Flavour is an important parameter when evaluating sensory attribute of food. The product might be appealing but without good flavor, it is likely to be unacceptable. Table 7 and 8 shows that the sensory scores for flavour was higher in the pomegranate peel tea compared to the commercial tea. This was due to the strong bitter flavor of the commercial tea which was found to be unacceptable. Eventhough sugar masked the bitterness, the pomegranate

peel tea was found to be more acceptable when compared to the commercial tea. Bitterness is usually unpleasant, but sometimes desirable in moderate amounts, and is perceived predominantly at the back of, and sometimes alongside of, the tongue (Chaturvedula and Prakash, 2011).

Table 7 and Table 8 shows that the sensory scores for aftertaste was higher in the pomegranate peel tea when compared to the commercial tea. Table 8 shows that the tea samples containing 2 grams of pomegranate peel powder and commercial tea powder was most acceptable by the panel member followed by tea samples containing 3 grams of pomegranate peel powder and commercial tea powder. The tea samples containing 5 grams of pomegranate peel powder and commercial tea powder was the least accepted due to their bitter after taste. Table 8 shows that the tea samples containing 2, 3 and 5 grams of pomegranate peel powder and commercial tea powder were fairly accepted by the panel members, because of added sugar. The pomegranate peel tea was highly acceptable when compared to the commercial tea.

Astringency is a drying, puckering sensation in the mouth that affects the whole of the tongue more or less uniformly (Chaturvedula and Prakash, 2011). Table 7 shows that the sensory scores for astringency was higher in the commercial tea when compared to the pomegranate peel tea this is due to the strong astringent taste of the pomegranate peel powder in which was found to be unacceptable. The mean scores decreased with the increase in concentration of pomegranate peel powders. Table 8 shows that all the tea samples were fairly accepted by the panel members except for the tea samples containing five grams of pomegranate peel powder and commercial tea powder which was found to be unacceptable by the panel members.In all the parameters, the tea samples containing two grams of pomegranate peel powder and commercial tea powder with added sugar were found to be the most accepted sample by the panel members.

From the present study, it is evident that the pomegranate peel powder had a better nutritional composition and phenolic constituents compared to the commercial tea powder. The pomegranate peel powder has better antioxidant properties and exhibited cardio protective effects. Though the total plate count was higher in the pomegranate peel powder, the shelf life can be extended with the help of hygienic manufacturing practices and good packaging techniques.

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