

Original Research Article

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Effect of Different Treatments on Quality of Nutri-Enriched Cookies Fortified with Pomegranate Peel Powder and Defatted Soybean Flour

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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 (*Punica granatum* L.) 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 (Mirdehghan and Rahemi, 2007). The soybean (*Glycine max*) a grain legume, is one of the richest and cheapest sources of plant protein that can be used to improve the diet of millions of people, especially the poor and low income earners in developing countries because it produces the greatest amount of protein used as food by man (Liu, 2000). The present investigation aims at studying the nutritional quality of cookies as influenced by different treatments. Among different treatments T₇ [65% Refined wheat flour + 5% Pomegranate peel powder + 30% Defatted soybean flour] was found to be nutritionally superior as well as organoleptically acceptable by the consumer.

Keywords

Pomegranate peel powder (PPP), defatted soybean flour (DSF), refined wheat flour (RWF)

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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).

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 (*Punica granatum* L.) 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 (Mirdehghan and Rahemi, 2007).

Recycling byproducts or processing waste is of great importance from environmental point of view as well as the health benefits derived from the extracted bioactive compounds. This product may be used as such or after further value addition. Solid and liquid waste recycling is emerging as one of the important areas in research for achieving efficiency in utilization of all the raw material or inputs so as to reduce the cost of production.

The soybean (*Glycine max*) a grain legume, is one of the richest and cheapest sources of plant protein that can be used to improve the diet of millions of people, especially the poor and low income earners in developing countries because it produces the greatest amount of protein used as food by man (Liu, 2000).

Functional foods are the food components that benefits health beyond the basic nutrition. Conventional foods, enriched or enhanced foods, dietary supplements and fortified foods are some of the examples of functional foods.

These substances provide essential nutrients often beyond quantities necessary for normal maintenance, growth, development and other biologically active component that impart

desirable physiological effects (Drozen and Harrison, 1998). Baking Industry is considered to be one of the major segments of food processing in India. Baked products have popularities in the populace because of their availability, ready to eat convenience and reasonably good shelf life (Vijayakumar, 2013). Cookies are different from other baked products like bread and cakes because of their low moisture content which ensures less chance of microbial spoilage to provide a longer shelf life, making large scale production and distribution possible (Dhankar, 2013).

In the present experiment, different levels of pomegranate peel powder attempted to study physico-chemical quality of nutri-enriched cookies.

Materials and Methods

Plant material

The experiment was conducted in the Dept. of Post-Harvest Technology, College of Horticulture, Bagalkot. Pomegranate fruits of variety were procured from farmer's field in kaladgi, Bagalkot District. soybean flour procured from ahmed shopping centre Bangalore. Other ingredients were procured from the local market, Bagalkot.

Production of pomegranate peel powder

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 and washed again with tap water and drained off water peels were spread on stainless steel tray and dried under ceiling fan o remove surface water. These peels were taken for drying.

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 chemical analysis and for fortification in cookies with wheat flour.

Standard formulation for preparation of cookies

The standard formula of cookies (Table 1) was used for the preparation of pomegranate peel powder and defatted soybean flour fortified cookies. Only the main ingredient refined wheat flour was replaced with the pomegranate peel powder at 2.5% and 5%, soybean flour at 25% and 30% level.

Observations recorded

Moisture content (%)

Moisture content was measured by slightly modifying the hot air oven method (Anon, 1980). 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 nutri-enriched cookies 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

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 fibra plus instrument and then 100ml 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 100ml 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 instrument as 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 place the thimbles in thimble holder and keep the thimble holder 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:

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

Sensory evaluation

Sensory evaluation of nutri-enriched was carried out by a semi trained panel consisting of Teachers and Post-Graduate students of College of Horticulture, Bagalkot with the

help of nine point hedonic rating scale (1 = dislike extremely, 2 = like only slightly, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely) for colour and appearance, texture, taste, flavour and overall acceptability (Swaminathan, 1974).

Statistical analysis

The data on sensory evaluation, quality analysis and storage studies of nutri enriched cookies fortified with pomegranate peel powder and defatted soybean flour was carried out by using Completely Randomized Design (CRD) analysis. Interpretation of data in accordance with Panse and Sukhatme (1985). The level of significance used in 'F' and 't' test was $p=0.01$. Critical difference values were calculated whenever 'F' test found significant.

Results and Discussion

Moisture (%) and water activity (a_w)

The data on moisture content of nutri-enriched pomegranate peel powder and defatted soybean flour fortified cookies as influenced by different treatments is presented in Table 1. The data revealed significant differences among the treatments with respect to moisture content of nutri-enriched cookies. The minimum moisture content was recorded in the treatment T_1 (control: 2.36%) and it was found to be significantly different with the other treatments. Maximum moisture was recorded in T_7 (2.50%) treatment. The increase in moisture content of cookies containing pomegranate peel powder and defatted soybean flour might be due to increased water absorption of dietary fiber present in PPP (pomegranate peel powder) when compared to refined wheat flour. The high water absorption capacity of fiber

present in pomegranate peel powder is due to more hydroxyl groups of cellulose in the fiber able to bind with free water molecules through hydrogen bonding and thus resulting in greater water holding capacity. Similar findings are reported by many workers (Ingle and Thorat, 2012; Ashoush and Gadallah, 2011; Paul and Bhattacharyya, 2015; Sindhu *et al.*, 2016) in biscuit incorporated with defatted soya flour and carrot pomace powder. Thorat and Khemnar (2013) reported that as the jamun seed powder incorporation level increased in cookies the moisture content increased from 2.2 to 4.8 per cent. Potato peel powder incorporation in cookies by Dhingra *et al.*, (2012) also observed the similar results.

The data regarding water activity of nutri-enriched pomegranate peel powder and defatted soybean flour fortified cookies as influenced by different treatments is presented in Table 1. The data on water activity was found to be significant with respect to treatments. The minimum water activity was obtained in the treatment T₁ (0.39) and it was significantly different from all other treatments. The maximum water activity of 0.51 was recorded in the treatment T₇ (65% RWF + 5% PPP + 30% DSF). Physicochemical and microbiological stability of food depends greatly on the water content and its interaction with food ingredients. Water activity is a measure of the availability of water molecules to enter into microbial, enzymatic or chemical reactions. The water activity concept has been used as a reliable assessment of the microbial growth and chemical stability of foods. There is no microbial proliferation below water activity of 0.6 (Rahman and Labuza, 1999). In this study, all measured water activity levels in the treatments were in the range of 0.39 to 0.51. So it confirms that the cookies would not be susceptible to any microbial or chemical activities. These results are in close

conformity with Alsenaien *et al.*, (2015) in substitution of sugar with date's powder and dates syrup in cookies making. Hosmani *et al.*, (2016) in their study reported that the moisture content and water activity values of the biscuits indicate the values are in the safe range of storage quality.

Total ash content, crude fat and fibre (%)

In the present study, the total ash content (Table 1) was significantly higher in treatment T₇ (65% refined wheat flour + 5% pomegranate peel powder + 30% defatted soybean flour: 8.19%). The minimum total ash content was observed in the control *i.e.* T₁ (6.19 %) in 100% refined wheat flour cookies. This might be attributed to the higher amounts of mineral present in the pomegranate peel powder and soybean flour. Similar results are obtained by Okoye *et al.*, (2008) in wheat flour and soybean flour blend fortified biscuits and observed that all the flour blends differed significantly ($p < 0.05$) from each other for ash content. The differences were observed because the ash content of the blends increased steadily with increasing content of soybean flour (SF). Legumes have been reported to be good sources of ash (Pyke, 1981). The results obtained for ash content are in conformity with the findings of various workers (Sindhu *et al.*, 2016; Bazilla *et al.*, 2012; Singh *et al.*, 2012).

The observations related to crude fat content of nutri-enriched pomegranate peel powder and defatted soybean flour fortified cookies as influenced by different treatments is presented in Table 1. The data revealed there was no significant difference was observed among the treatments with respect to crude fat content of nutri-enriched cookies. The fat content had a range from T₁ (21.35%) to (21.56%) was recorded in the treatment (T₇: 65% RWF + 5% PPP + 30% DSF) followed by T₃ (21.55%).

Fig.1 Flow chart for preparation of cookies

Flour with different levels of refined wheat flour, pomegranate peel powder and defatted soybean

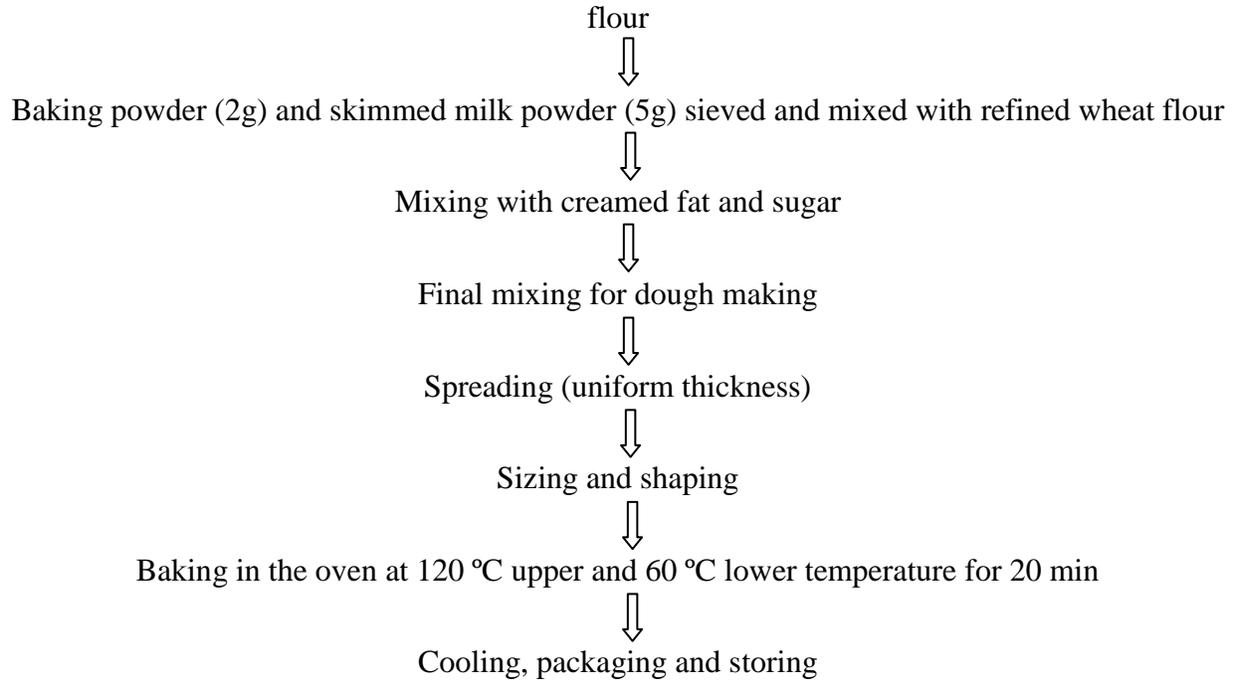


Table.1 Effect of fortification of pomegranate peel powder and defatted soybean flour on moisture, water activity, ash, crude fat and fibre content of nutri-enriched cookies

Treatments		Moisture (%)	Water activity (aw)	Ash (%)	Fat content (%)	Crude Fibre (%)
T ₁ :	100% RWF	2.36	0.39	6.19	21.35	13.72
T ₂ :	72.5% RWF + 2.5% PPP + 25% DSF	2.43	0.44	7.14	21.52	17.74
T ₃ :	70% RWF + 5% PPP + 25% DSF	2.45	0.45	7.25	21.55	18.34
T ₇ :	65% RWF + 5% PPP + 30% DSF	2.50	0.51	8.19	21.56	19.46
	Mean	2.43	0.44	7.19	21.49	17.31
	SEm ±	0.024	0.034	0.084	0.174	0.063
	CD at 1%	0.03	0.04	0.32	NS	0.27

The above treatments includes the following ingredients in common

RWF: Refined wheat flour **PPP:** Pomegranate peel powder **DSF:** defatted soybean flour

Sugar :50 Hydrogenated fat : 50g

Milk powder :5g Baking powder : 5g

NS: Non-significant

powder; Nassar *et al.*, (2008) also revealed increase in fibre with increase in mandarin peel percentage in biscuit, Youssef and Mousa (2012) also reported increase in fibre content in biscuit with addition of different citrus peel powder.

Sensory evaluation

The evaluation of sensory quality of a product is very important tool for deciding the consumer acceptability. Human elements play an important role in evaluation of organoleptic characters of a product. For a new product, the consumer acceptability needs to be evaluated first at laboratory level. The results of organoleptic evaluation (Table. 2) indicated that the cookies fortified with 65% Refined wheat flour + 5% pomegranate peel powder + 30% defatted soybean flour (T₇) scored better than other treatments for all the four organoleptic parameters except taste. Another recipe of cookies T₂ was on par with T₇. Flavour is the combined perception of taste, odour and mouth feel (Benoit, 2004). It appears that the highly acceptable flavour, colour and texture and overall acceptability might have been achieved in the treatment T₇ (65% RWF + 5% PPP + 30% DSF) and the lower organoleptic scores were recorded in T₃ (70% RWF + 5% PPP + 25% DSF) may be due to astringency flavour of phenolic content reduced the flavor. Similar results were reported by Ismail *et al.*, (2014) in pomegranate peel powder supplemented cookies who reported improvement of crude fibre contents in pomegranate peel powder supplemented cookies, might have a featured product hardening property imparting characteristic sensorial score decline. Addition of PoP at 6 per cent level did not manifest any undesirable organoleptic response and the product remained acceptable below 7.5 per cent supplementation. Paul and Bhattacharya (2015) reported that 10 per cent pomegranate juice and peel powder fortified

cookies have flavor of fresh Pomegranate. Overall, it can be concluded that the substitution of wheat flour with bottle gourd powder up to 7-10 per cent into the formulation of cookies enhanced the nutritional value of cookies; Bazilla *et al.*, (2012) observed the mean overall sensory acceptability scores of more than 8.50 for biscuit samples incorporated upto 5% carrot pomace powder indicated the commercial scope for manufacturing good quality vegetarian biscuits with carrot pomace powder and defatted soy flour.

The composition of [T₇: 65% RWF + 5% PPP + 30% DSF] was found nutritionally superior as well as recorded highest score in sensory properties and it can be concluded that the substitution of wheat flour with pomegranate peel powder up to 5 per cent with 30% defatted soybean flour into the formulation of cookies enhanced the nutritional value as well as sensory properties.

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