Development of Cookies Incorporated with Pomegranate Seed Powder and Defatted Soybean Flour

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ABSTRACT

Pomegranate seeds (PS) are valuable sources of bioactive phytochemicals and can be used as substrate for the production of nutritionally valuable and biologically active components that could find several applications as functional food ingredients, food additives, nutraceuticals and supplements and in phenolic-rich diets. Soybeans tend to play a dietary role despite the fact that they are excellent sources of protein, dietary fiber and a variety of micronutrients and phytochemicals. Soybean will improve the nutritional status of the bakery products when it is used partially to replace wheat flour. Thus, the aim of the present study was to investigate the potential use of pomegranate seed powder (PSP) and defatted soybean flour (DSF) as a functional ingredient in the development of cookies and to determine its effects on nutritional composition of cookies. Different concentrations of PSP (5%, 10%, 15% and 20%) and DSF (25% and 30%) have been fortified in cookies formulations by replacement of refined wheat flour (RWF). The highest scores for overall acceptability were recorded in the treatment T1 [100% RWF (control); 8.07] followed by T2 [70% RWF +5% PSP + 25% DSF; 7.73]. The best four treatments, along with the control were taken from the sensory evaluation were analyzed for nutrient composition. Among the different treatments, treatment T4 (60% RWF +15% PSP + 25% DSF) recorded the highest protein (7.89%), ash (7.54%), crude fiber (17.10%) fat (24.54%) and total phenol content (18.40 mg GAE/g). Fortification of pomegranate seed powder and defatted soybean flour in cookies enhanced the nutrient composition.

KEYWORDS

Pomegranate seed powder (PSP); defatted soybean flour (DSF); cookies; Protein; Sensory; Crude fiber; Ash

Introduction

Pomegranate (Punica granatum L.) is an important fruit from tropical and subtropical regions. India is the world leading country in pomegranate production. Its popularity comes from the fact that they are very rich in compounds such as polyphenols, flavonoids, anthocyanin, ascorbic acid, ellagic acid, carotenoids, and tannins. Fruit and vegetable processing in India generates substantial quantities of waste and these wastes of fruits are an abundant source of antioxidants and polyphenols. Pomegranate seed contains large amount of nutraceutical components such as punicic acid, sterols, tocopherols and hydroxyl benzoic acid (Liu et al., 2009). Unsaturated fatty acid and phenolic compounds and also small quantities of phenyl aliphatic glycoside present in seeds (Wang et al., 2004). The extracts of pomegranate seed were reported with anti-oxidants and anti-diarrheal bioactivities (Singh et al., 2002). So pomegranate seeds, the by-product of pomegranate juice processing are a valuable pharmaceutical and nutritional compound. Seeds can have more beneficial application in food industries instead of being used as an animal feed. A grain legume soybean (Glycine max), is one of the cheapest and richest sources of plant protein that can be utilized for improving the diet of millions of people, especially the poor and low-income earners in developing countries because it produces the highest amount of...
protein which is used as a food by man (Liu, 2000). Amino acid profile of soy protein is excellent amongst plant proteins. Hence, it is superior to other plant proteins as it contains most of the essential amino acids except methionine (FAO), which is abundant in cereals, and it is the most economical source of dietary protein. Soy protein directly lowers serum cholesterol levels (Mirrahimi et al., 2010). It is also a good source of vitamin, minerals and is relatively low in crude fiber (Oyegbade, 1968). Soybean will improve the nutritional status of the bakery products when it is used partially to replace wheat flour. With this background the present investigation was undertaken to improve the nutritional and functional quality of cookies by the fortification of pomegranate seed powder and defatted soybean flour.

**Material and Methods**

An experiment on development of cookies incorporated with pomegranate seed powder and defatted soybean flour was carried out in the department of Post-harvest Technology, College of Horticulture, Bagalkot, Karnataka during 2018–19. Pomegranate fruits of variety 'Bhagwa' were collected from the Pomegranate orchard, Fruit Research Station, Sector 70, University of Horticultural Sciences, Bagalkot. Bagalkot is located in northern dry zone (KA-3) of Karnataka. The center is located at 75.70 East longitude and 16.18 North latitude with an altitude of 537.00 m above mean sea level (MSL).

Defatted soybean flour was procured from MK Ahmed Retail Shopping Center, Bangalore. Other ingredients such as sugar, baking powder, hydrogenated fat and wheat flour were procured from M P Shettar Super Market, Bagalkot.

**Optimization of pomegranate seed powder**

Pomegranate fruits of optimum maturity with attractive red color were harvested and brought to the Department of Post Harvest Technology, College of Horticulture, Bagalkot. After washing with tap water, fruits were cut into two parts with a stainless steel knife. The juice was extracted by using a pomegranate juice extractor and then peel and seeds were separated manually. Seeds obtained after juice extraction were used for further experiments.

**Pre-treatment of Pomegranate Seeds**

After separation from the peel and other waste parts, the seeds were pre treated with 2% salt solution for 10 minutes in order to remove the juice and other aril part attached with the seed. Salt water was drained off and seeds were washed again with tap water. Tap water was separated from the seed by using a stainless steel sieve and thereafter dried under a ceiling fan to remove surface water. These seeds were taken for a further dehydration process.

**Dehydration and Powdering of Pomegranate Seed**

After pre-treatment the pomegranate seeds were placed in a tray drier at 65°C for 24 hr to obtain the dried seeds. The dried pomegranate seeds were crushed in a mixer grinder. The powder obtained was passed through a 0.5 mm size mesh sieve. Pomegranate seed powder was packed in aluminum pouches for further chemical analysis and for fortification in cookies together with wheat flour.

**Standard Recipe for Cookies Preparation**

The standard formula of cookies was refined wheat flour (100 g), sugar (50 g), hydrogenated fat (50 g), skimmed milk powder (5 g) and baking powder (2 g). The same formula was used for the preparation of pomegranate seed powder (PSP) and defatted soybean flour (DSF) cookies (Figure 1). Only the
Flour with different level of pomegranate seed powder, defatted soybean flour and refined wheat flour

Baking powder (2g) and skimmed milk powder (5g) sieved and mixed with refined wheat flour

Mixing with hydrogenated fat and sugar

Final mixing for dough making

Spreading (uniform thickness)

Sizing and shaping

Baking in the oven at 120°C upper and 60°C lower temperature for 20 minutes

Cooling, packing and storing

Figure 1. Flow chart for preparation of cookies.

main ingredient, refined wheat flour was replaced *i.e.*, replacement of wheat flour with the pomegranate seed powder at 5%, 10%, 15% and 20% and soybean flour was incorporated at 25% and 30% level (Table 1).

**Observations Recorded**

**Sensory Evaluation**

Sensory evaluation of cookies incorporated with pomegranate seed powder and defatted soybean flour was carried out by 15 semi trained panelists consisting of lectures and post-graduate students of the College of Horticulture, Bagalkot with the help of a 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 color, flavor, taste, texture and overall acceptability (Swaminathan, 1974). The products along with control, were coded and served randomly to the panelists for sensory evaluation, immediately after preparation (Plate 1).

**Table 1.** Recipe for pomegranate seed powder and defatted soybean flour incorporated cookies.

| Treatments | Pomegranate Seed powder (PSP %) | Defatted soybean flour (DSF %) | Refined wheat flour (g) | Butter (g) | Sugar (g) | Baking powder (g) | Milk powder (g) |
|------------|---------------------------------|--------------------------------|--------------------------|------------|-----------|------------------|---------------|
| T₁         | 0                               | 0                              | 100                      | 50         | 50        | 2                | 5             |
| T₂         | 5                               | 25                             | 70                       | 50         | 50        | 2                | 5             |
| T₃         | 10                              | 25                             | 65                       | 50         | 50        | 2                | 5             |
| T₄         | 15                              | 25                             | 60                       | 50         | 50        | 2                | 5             |
| T₅         | 20                              | 25                             | 55                       | 50         | 50        | 2                | 5             |
| T₆         | 5                               | 30                             | 65                       | 50         | 50        | 2                | 5             |
| T₇         | 10                              | 30                             | 60                       | 50         | 50        | 2                | 5             |
| T₈         | 15                              | 30                             | 55                       | 50         | 50        | 2                | 5             |
| T₉         | 20                              | 30                             | 50                       | 50         | 50        | 2                | 5             |
A* Value

Cookies color was measured with a Color Flex EZ (Model CFEZ 1919, Hunter Associates Laboratory, Inc., Reston) with a 45 mm (diameter) measuring tube using a white tile background. 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 cookies samples for each treatment.

From sensory evaluation the best three treatments for overall acceptability along with control were analyzed for quality parameters like moisture, protein, fat, ash and crude fiber.

Nutrient Composition

Moisture was determined by using moisture balance (RADWAG MAC50). Two gram of pomegranate seed powder and defatted soybean flour incorporated cookies was placed in the sample dish and dried in the electric moisture balance until it automatically showed the moisture in percentage. The instrument indicates the end point of measurement by a beep sound and gives the constant value for moisture and it was expressed in percentage. Determination of protein content was carried out by the micro Kjeldhal method which consists of wet digestion, distillation and titration (Anon., 2005). Crude fiber estimation was done by using a Fibra plus-FES-6 instrument. Fat content of pomegranate seed powder and defatted soybean flour incorporated cookies was determined by using the Socs plus-SCS-6AS instruments described by Ojure and Quadri (2012). Total ash content of pomegranate seed powder and defatted soybean flour incorporated cookies was determined by burning the pomegranate seed powder in pre-weighed crucible in a muffle furnace at 500°C for 6 hours (Rao and Bingren, 2009).

Total Phenol Content (Mg GAE/g)

Total phenol content of cookies incorporated with pomegranate seed powder and defatted soybean flour was estimated by using Folin-Ciocalteu Reagent (FCR) method and expressed as mg Gallic acid equivalent per gram (Sadashivam and Manickam, 2005).

Antioxidant Activity (%)

The ability of cookies fortified with pomegranate seed powder and defatted soybean flour to scavenge the Table 2, 2’-diphenyl-2-picrylhydrazyl (DPPH) free radical was assessed according to the method of Egdhami and Asli (2010).
Table 2. Effect of incorporation of pomegranate seed powder and defatted soybean flour on sensory evaluation and $a^*$ value of cookies.

| Treatments         | Color | Flavor | Taste | Texture | Overall acceptability | Average | Rank | $a^*$  |
|--------------------|-------|--------|-------|---------|-----------------------|---------|------|--------|
| T<sub>1</sub>: 100% RWF (control) | 8.15<sup>a</sup> | 7.60 | 7.85 | 7.79 | 8.07 | 7.89 | I | 5.24<sup>cd</sup> |
| T<sub>2</sub>: 70% RWF + 5% PSP + 25% DSF | 7.82<sup>ab</sup> | 7.74 | 7.77 | 7.73 | 7.73 | 7.76 | II | 5.89<sup>bc</sup> |
| T<sub>3</sub>: 65% RWF + 10% PSP + 25% DSF | 7.65<sup>ab</sup> | 7.40 | 7.62 | 7.68 | 7.65 | 7.60 | III | 6.11<sup>b</sup> |
| T<sub>4</sub>: 60% RWF + 15% PSP + 25% DSF | 7.43<sup>abc</sup> | 7.60 | 7.60 | 7.68 | 7.69 | 7.60 | III | 6.12<sup>b</sup> |
| T<sub>5</sub>: 55% RWF + 20% PSP + 25% DSF | 7.10<sup>c</sup> | 7.56 | 7.52 | 7.52 | 7.42 | 7.42 | VII | 6.93<sup>a</sup> |
| T<sub>6</sub>: 70% RWF + 5% PSP + 30% DSF | 7.77<sup>ab</sup> | 7.50 | 7.55 | 7.39 | 7.38 | 7.52 | V | 5.56<sup>c</sup> |
| T<sub>7</sub>: 65% RWF + 10% PSP + 30% DSF | 7.63<sup>c</sup> | 7.48 | 7.38 | 7.15 | 7.45 | 7.42 | VII | 5.74<sup>c</sup> |
| T<sub>8</sub>: 60% RWF + 15% PSP + 30% DSF | 7.43<sup>abc</sup> | 7.53 | 7.39 | 7.48 | 7.62 | 7.49 | VI | 6.41<sup>bc</sup> |
| T<sub>9</sub>: 55% RWF + 20% PSP + 30% DSF | 7.05<sup>c</sup> | 7.80 | 7.67 | 7.54 | 7.71 | 7.56 | IV | 6.90<sup>a</sup> |
| Mean              | 7.56 | 7.58 | 7.59 | 7.55 | 7.64 | 7.58 | - | 6.10 |
| S.E.m±             | 0.10 | 0.16 | 0.14 | 0.16 | 0.14 | - | - | 0.16 |
| CD at 1%           | 0.45 | NS | NS | NS | NS | NS | - | 0.64 |

Values with different superscript letters indicate statistical difference.
Note: CD at 1% level of significance S.E.m: Standard Error Mean

Statistical analysis

The data on sensory analysis and nutrient composition of pomegranate seed powder and defatted soybean flour incorporated cookies was carried out by using Completely Randomized Design (CRD) analysis. The data was interpreted in accordance with Panse and Sukathme (1985). The level of significance used in ‘F’ and ‘t’ test was $p = .01$. Critical difference values were calculated whenever ‘F’ test was found significant.

Results and discussion

Sensory evaluation of products is an important tool for deciding the consumer acceptability. Cookies were prepared by incorporating pomegranate seed powder, defatted soya flour as well as refined wheat flour with other ingredients. Sensory evaluation of developed cookies was carried out by using 9-point hedonic scales by the panelists. Inclusion of different ratios of pomegranate seed powder in cookies resulted in non-significant differences except for color, on sensory characteristics of cookies (Table 2) and (Plate 1). As the percentage of pomegranate seed powder increased, the color, flavor, taste, texture and overall acceptability of cookies were appreciated up to certain level beyond which scores were decreased for these sensory parameters.

Color is the key parameter that determines consumer preference (Leon et al., 2006). Color was found to be significantly highest in control cookies prepared with 100% refined wheat flour (T<sub>1</sub>: 8.15) and this may be due to the bright attractive white color of the cookies. Incorporation of pomegranate seed powder contributed dark color to cookies after baking and therefore, less acceptable by the judges. Increase in darkness value also reflected in $a^*$ values of the pomegranate seed powder (Table 2) (Plate 2) in the present study.

Flavor is a sensory impression of food or other substances determined primarily by chemical senses of taste and smell. The flavor of cookies incorporated with pomegranate seed powder and defatted soybean flour is presented in Table 2. The highest flavor score was recorded in the treatment T<sub>9</sub> (55% RWF + 20% PSP + 30% DSF: 7.80) and the lowest score was observed in the treatment T<sub>3</sub> (65% RWF + 10% PSP + 25% DSF: 7.40). However, treatments were found to be non significant.
Taste is the sensation of flavor perceived in the mouth and throat on contact with a substance. The taste of pomegranate seed powder and defatted soybean flour incorporated cookies, as rated by panelists was from “like slightly” to “dislike slightly.” The data revealed that there was no significant difference observed among the treatments with respect to sensory scores for taste. However, the highest score for taste was recorded in the treatment T1 (100% RWF (control): 7.85) and the lowest score was observed in the treatment T7 (65% RWF + 10% PSP + 30% DSF: 7.38).

The observations related to sensory scores for texture of cookies incorporated with pomegranate seed powder and defatted soybean flour as influenced by different treatments used in the present study, showed no significant difference in scores among the treatments. Sensory scores for texture had a range from 7.15 (T7: 65% RWF + 10% PSP + 30% DSF) to 7.79 (T1: 100% RWF).

The data revealed that there was no significant difference found to exist with respect to sensory scores for overall acceptability. This indicates that the incorporation of pomegranate seed powder and defatted soybean flour up to 20% and 30%, respectively in cookies formulation were accepted at optimum level for all sensory parameters like taste, flavor and texture except for color.

The treatment T1 (100% RWF) as control, T2 (70% RWF + 5% PSP + 25% DSF), T3 (65% RWF + 10% PSP + 25% DSF) and T4 (60% RWF + 15% PSP + 25% DSF) were considered as optimum based on rank through sensory evaluation (Table 2). These four treatments were further studied for nutrient composition viz., moisture, protein, fat, crude fiber and ash.

Moisture content of cookies incorporated with pomegranate seed powder and defatted soybean flour showed no significant difference among the treatments (Table 3). However, the increase in moisture content of cookies containing pomegranate seed powder and defatted soybean flour might be due to increased absorption of water by crude fiber present in pomegranate seed powder. The high water-holding capacity of fiber present in the pomegranate seed is due to more hydroxyl groups of cellulose in the fiber able to bind with free water molecule through hydrogen bonding and thus results

Plate 2. Cookies incorporated with pomegranate seed powder and defatted soybean four.
Table 3. Effect of incorporation of pomegranate seed powder and defatted soybean flour on nutritional quality of cookies.

| Treatments | Moisture (%) | Protein (%) | Crude Fat (%) | Crude fiber (%) | Ash (%) | Total phenol content (mg GAE/g) | Antioxidant Activity (%) |
|------------|--------------|-------------|---------------|----------------|---------|---------------------------------|-------------------------|
| T1: 100% RWF | 2.61         | 4.02<sup>c</sup> | 20.70<sup>c</sup> | 12.77<sup>b</sup> | 4.88<sup>d</sup> | 6.20<sup>f</sup> | 41.18 |
| T2: 70% RWF + 5% PSP + 25% DSF | 2.74         | 6.18<sup>b</sup> | 21.32<sup>c</sup> | 15.41<sup>a</sup> | 5.40<sup>f</sup> | 9.00<sup>c</sup> | 44.71 |
| T3: 65% RWF + 10% PSP + 25% DSF | 2.88         | 6.87<sup>b</sup> | 23.00<sup>b</sup> | 15.69<sup>a</sup> | 6.10<sup>b</sup> | 15.50<sup>b</sup> | 47.78 |
| T4: 60% RWF + 15% PSP + 25% DSF | 3.06         | 7.89<sup>a</sup> | 24.54<sup>a</sup> | 17.10<sup>a</sup> | 7.54<sup>a</sup> | 18.40<sup>a</sup> | 51.11 |

**Mean**

|          | 2.82         | 6.24         | 22.39         | 15.24         | 5.98         | 12.28         | 46.19         |
|----------|--------------|-------------|---------------|---------------|--------------|---------------|---------------|
| S.Em±    | -            | 0.19        | 0.29          | 0.46          | 0.09         | 0.70          | -             |
| CD at 1% | NS           | 0.79        | 1.23          | 1.91          | 0.37         | 2.88          | NS            |

**CD at 1% level of significance S.Em: Standard Error Mean**

Values with different superscript letters indicate statistical difference

in greater water-holding capacity (Goff and Guo, 2019). Similar findings are reported by many workers. Ashoush and Gadallah (2011) and Aslam et al. (2009) reported higher moisture content in mango peel supplemented biscuits than control. The dough containing extruded orange pulp showed the highest moisture content, due to the high water absorption capacity of staple fibers (Larrea et al., 2005).

| Sugar-50 g | Milk powder-5 g | Butter-50 g | Baking powder-2 g |
|------------|-----------------|-------------|------------------|
| RWF- Refined wheat flour | PSP-Pomegranate seed powder | DSF-Defatted Soybean flour | *Score out of 9 |
| NS- Non significant |               |             |                  |

The data regarding protein content of pomegranate seed powder and defatted soybean flour incorporated cookies as influenced by different treatments is presented in Table 3. The data revealed significant differences among the treatments with respect to protein content of cookies. Significantly higher protein content (7.89%) was found in treatment T<sub>4</sub> (60% RWF + 15% PSP + 25% DSF). A minimum protein (4.02%) content was recorded in the treatment control T<sub>1</sub> (100% RWF) and it differed significantly from the rest of treatments. This was mainly due to the addition of defatted soybean flour and pomegranate seed powder. Soybeans are legumes that are rich in protein content. Defatted soybean flour used in the present study contain 52% protein, as mentioned on the packing label. Soybean is an outstanding source of protein and a compliment to lysine-limited cereal protein. Quality and quantity of protein content in the food can be improved by the addition of soy flour; thereby has the excellent ability in combating protein energy malnutrition (Hassan, 2013). Pomegranate seed powder was found to be a rich source of protein (15.69%) and could contribute to protein content in cookies (Harish, 2019). These results obtained are also in conformity with the findings of Paul and Bhattacharyya (2015) who reported that there was a significant increase in the protein content in the pomegranate peel powder fortified cookies and the protein increased with the increase in the levels of fortification. Okoye et al. (2008) revealed that the biscuits produced from the mixture with a greater concentration of soybean flour contained more protein than those produced from mixtures containing less soybean flour.

The results in Table 3 on crude fiber content of pomegranate seed powder and defatted soybean flour incorporated cookies with different concentration of RWF, PSP and DSF showed significant differences among the treatments. Highest crude fiber content (17.10%) of cookies was recorded in the treatment T<sub>4</sub> (60% RWF + 15% PSP + 25% DSF) and it was on par with treatments T<sub>3</sub> (15.69%) and T<sub>2</sub> (15.41%). Significantly lower crude fiber content of 12.77% was found in cookies prepared from control T<sub>1</sub> i.e., 100% refined wheat flour. This may be due to addition of pomegranate seed, which is a wealthy source of fiber. As per the findings of the
present study, the crude fiber content of pomegranate seed powder was 23.58% (Harish, 2019) and in turn, it will add more fiber to the cookies according to per cent incorporation. These results are in close conformity with that of Baljeet et al. (2014) who reported that an increase in the concentration of carrot pomace powder and germinated chick pea flour, caused an increase in crude fiber contents. Hanan and Rasha (2012) reported high fiber in wheat biscuits fortified with citrus peel powders.

The observations related to crude fat content of pomegranate seed powder and defatted soybean flour incorporated cookies as influenced by different treatments is presented in Table 3. The data revealed that there were significant differences among the treatments with respect to crude fat content of cookies. Significantly, higher crude fat (24.54%) was observed in the cookies of treatment T₄ (60% RWF + 15% PSP + 25% DSF) followed by T₃ (65% RWF + 10% PSP + 25% DSF: 23.00%). Treatment control T₁ (100% RWF: 20.70) and T₂ (70% RWF + 5% PSP + 25% DSF: 21.32%) were on par with each other for crude fat content (Table 3). This was mainly due to the addition of pomegranate seed powder, which is a rich source of unsaturated fatty acids (Pereira de Melo et al., 2014). The findings of the present study are in accordance with Uchoa et al. (2009) who reported high amount of crude fat in cookies supplemented with cashew and guava fruit powder. Dachana et al. (2010) and Mouminah (2015) reported that the contents of protein, fat and minerals in cookies increased with incorporation of increasing levels of dried moringa leaf powder. Choudhury et al. (2015) reported that fat content of cookies increased from 14.16% to 15.29% with increased level of fortification with bamboo shoot powder.

The results pertaining to the total ash content of pomegranate seed powder and defatted soybean flour incorporated cookies as influenced by different treatments is presented in Table 3. Significant differences were found among the treatments with respect to total ash content of cookies (Table 3). The maximum ash content (7.54%) was found in treatment T₄ (60% RWF + 15% PSP + 25% DSF), followed by T₃ (6.10%). This could be ascribed to a greater quantity of minerals in the pomegranate seed powder and soybean flour. Legumes have been reported to be good sources of ash (Pyke, 1981). In the present study the ash content of soybean flour was 6.00% and that of pomegranate seed powder was 2.88% in turn contributing to the higher values of ash proportionately in the cookies. Metwal et al. (2011) reported that an increase in ash content was seen with an increase in fenugreek seed and flax seed flour incorporations. The ash content found in the cookies prepared from cashew and guava fruit powder was significantly higher than that of conventional cookies (Uchoa et al., 2009). Ojha and Thapa (2017) recorded an increase in ash content with an increase in mandarin peel powder, which may be due to a greater percentage of ash in mandarin peel powder.

The effect of incorporation of PSP and DSF on total phenol content and antioxidant value of cookies was showed significant values and non significant values among the treatments respectively (Table 3 and Figure 2). Significantly highest phenol content (18.40 mg GAE/g) was recorded in the treatment T₄ (60% RWF + 15% PSP + 25% DSF) and the treatment prepared with 100% refined wheat flour showed minimum phenol content (6.20 mg GAE/g). The highest antioxidant activity (51.11%) was found in the treatment T₄ (60% RWF + 15% PSP + 25% DSF) followed by the treatment T₃ (65% RWF + 10% PSP + 25% DSF: 47.78%). The lowest antioxidant activity was observed in the treatment T₁ (100% RWF: 41.18%). Total phenol content and per cent antioxidant activity of the cookies was increased with the increasing level of incorporation of pomegranate seed powder. Paul and Bhattacharyya (2015) observed similar trend in increase of phenol content and antioxidant activity of cookies fortified with pomegranate peel powder. The phenolic content increased from 3.4 mg GAE/g to 15.3 mg GAE/g and 22.4 mg GAE/g of biscuits incorporated with 30% of mango peel powder and Mango kernel powder, respectively (Bandyopadhyay et al., 2014). Maner et al. (2017) inferred that total phenol content, flavonoids, antioxidant activities and tannins of cookies increased sharply after addition of whole grape pomace flour. Ashoush and Gadallah (2011) found similar increase in phenol content and antioxidant activity in study of utilization of mango seed and kernel powder as a source of phytochemicals in biscuits.
Conclusion

It can be concluded from the present investigation that cookies incorporated with pomegranate seed powder (PSP) and defatted soybean flour (DSF) at 15% and 25% level was found optimum through sensory scores and high protein (7.89%), crude fiber (17.10%) and ash content (7.54%). Exploring the possibility of utilizing pomegranate seed powder and defatted soybean flour in development of nutrient-enriched bakery products by replacing wheat flour as a promising fortificant may help to reduce synthetic additives associated health complications that generally leads to increased economic burden on the individual and the society.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

References

Anonymus. 2005. Official methods of analysis. 13th ed. Association of official analytical Chemists, Washington. DC.

Ashoush, I.S., and M.G.E. Gadallah. 2011. Utilization of mango peels and seed kernel powder as sources of phytochemicals in biscuit. World J. Dairy Food Sci 6(1):35–42.

Aslam, H.K.W., M.I.U. Raheem, R. Ramzan, A. Shakeel, M. Shoaib, and H.A. and Sakandar. 2014. Utilization of Mango waste material (peel, kernel) to enhance dietary fiber content and antioxidant properties of biscuit. J. Global Innov. Agri. Soci. Sci 2(2):76–81. doi: 10.17957/JGIASS/2.2.533.

Baljeet, S.Y., B.Y. Ritika, and K. Reena. 2014. Effect of incorporation of carrot pomace powder and germinated chickpea flour on the quality characteristics of biscuits. International Food Research Journal 21(1):217–222.

Bandopadhyay, K., C. Chakraborty, and S. Bhattacharyya. 2014. Fortification of mango peel and kernel powder in cookies formulation. J. Academia Industrial Res 2(12):661–664.

Choudhury, M., L.S. Badwaik, P.K. Borah, N. Sit, and S.C. Deka. 2015. Influence of bamboo shoot powder fortification on physico-chemical, textural and organoleptic characteristics of biscuits. J. Food Sci. Tech 52(10):6742–6748. doi: 10.1007/s13197-015-1709-3.

Dachana, K.B., J. Rajiv, D. Indrani, and J. Prakash. 2010. Effect of dried moringa (moringaoleifera lam) leaves on rheological, microstructural, nutritional, textural and organoleptic characteristics of cookies. J. Food Qual 33 (5):660–677. doi: 10.1111/j.1745-4557.2010.00346.x.

Egdhani, A., and D.E. Asli. 2010. Determination of antioxidant capacity of pomegranate juice by using 2,2-Diphenyl-1-picrylhydrazyl. Org. Chem. J 1:30–33.

FAO. Amino acid content of foods and Biological data on protein. Rome: Food and Agriculture Organization of the United Nations; 1970. Nutritional studies, 24.

Goff, H.D., and Q. Guo. 2019. Chapter 1: The role of hydrocolloids in the development of food structure. Handbook of Food Structure Development. 1–28. doi:10.1039/9781788016155-00001.
Hanan, M.K., and M.A. Rasha. 2012. Nutritional assessment of wheat biscuits and fortified wheat biscuits with citrus peels powders. Food and Pub. Health 21(1):55–60. doi: 10.5923/j.fph.201220.11.

Harish, T., 2019, Development of cookies from pomegranate seed powder and defatted soybean flour and evaluation of cookies for hypoglycaemic activity. M. Sc. (Hort.) Thesis, University of Horticultural Sciences, Bagalkote, Karnataka

Hassan, S.M. 2013. Soybean, Nutrition and Health. In: H.A. El-Shemy (ed.). Soybean-Bio-active compounds. Open access peer-reviewed.

Larrea, M.A., Y.K. Chang, and F. Martinez-Bustos. 2005. Some functional properties of extruded Orange pulp and its effect on the quality of cookies. LWT-Food Sci. Tech 38(3):213–220. doi: 10.1016/j.lwt.2004.05.014.

Leon, K., D. Leon, F. Mery, and L.J. Pedreschi. 2006. Colour measurement in L* a* b* units from RGB digital images. Food Res. International 39(10):1084–1091. doi: 10.1016/j.foodres.2006.03.006.

Liu, K. 2000. Expanding soybean food utilization. J. Food Tech 54(7):46–47.

Liu, G., X. Xu, Q. Hao, and Y. Gao. 2009. Supercritical CO2 extraction optimization of pomegranate (Punica granatum L.) seed oil using response surface methodology. LWT-Food Sci. Tech 42(9):1491–1495. doi: 10.1016/j.lwt.2009.04.011.

Maner, S., A.K. Sharma, and K. Banerjee. 2017. Wheat flour replacement by wine grape pomace powder positively affects physical, functional and sensory properties of cookies. Proc. National. Acad. Sci., India Section B: Biological Sciences 87 (1):109–113.

Metwal, N., R. Jyotsna, T. Jeyarani, and G.V. Rao. 2011. Influence of debittered, defatted fenugreek seed powder and flaxseed powder on the rheological characteristics of dough and quality of cookies. Int. J. Food Sci.Nutri 62 (4):336–344. doi: 10.3109/09637486.2010.536145.

Mirrahimi, A., K. Srichaikul, C.E. Berryman, L. Wang, A. Carleton, and S. Abdulnour. 2010. Soy protein reduces serum cholesterol by both intrinsic and food displacement mechanisms. J. Nutr 140(12):2302S–2311S. doi: 10.3945/ jn.110.124958.

Mouminah, H.H.S. 2015. Effect of dried moringaoleifera leaves on the nutritional and organoleptic characteristics of cookies. Alexandria Sci. Exch. J 36(4):297–302.

Ojha, P., and S. Thapa. 2017. Quality evaluation of biscuit incorporated with mandarin peel powder. Sci.Study Res Chem. Chem. Eng. Biotech. Food Ind 18(1):19.

Ojure, M.A., and J.A. Quadri. 2012. Quality evaluaton of noodles produced from unripe plantain flour using xanthan gum. Int. J. Res. Rev. Appl. Sci 13(3):740–752.

Okoye, J.I., A.C. Nkwocha, and A.E. Ogbonnaya. 2008. Production, proximate composition and consumer acceptability of biscuits from wheat/soybean flour blends. Continental J. Food Sci 5(2):50–56.

Oyenuga, V.A. 1968. Nigeria’s food and feeding stuffs, their chemistry and nutritive value. 3rd edition, Reprint. p. 20–26. Ibadan: Ibadan University Press.

Panse, V.G., and P.V. Sukathme. 1985. Statistical Methods for Agriculture Workers. Indian Council of Agriculture Research, New Delhi.

Paul, P., and S. Bhattacharyya. 2015. Antioxidant profile and sensory evaluation of cookies fortified with juice and peel powder of fresh pomegranate (Punica granatum). Int. J. Agric. Food Sci. 5(3):85–91.

Pereira de Melo, I.L., E.B. Teixeira de Carvalho, and J. Mancini-Filho. 2014. Pomegranate seed oil (Punica granatum L.): A source of punicic acid (Conjugated a-Linolenic Acid). Journal of Human Nutrition and Food Science 2 (1):1024–1034.

Pyke, M. 1981. Classification of Wheat: Food Science and Technology. 4th. John Murray Publishers Ltd, London. p. 44–56.

Rao, Y., and X. Bingren. 2009. Determination of total ash and acid insoluble ash by NIS. The Pharm. Soc. Japan 129 (7):881–886. doi: 10.1248/yakushi.129.881.

Sadashivam, S., and A. Manickam, 2005, Biochemical Methods. New Age International (P) Publishers, Second edition. Pp. 193–194.

Singh, R.P., K.N. Chidambra Murthy, and G.K. Jayaprakash. 2002. Studies on the antioxidant activity of pomegranate (Punica granatum) peel and seed extract using invitro models. J. Agric. Food Chem 50(1):81–86. doi: 10.1021/ jf010865b.

Swaminathan, M., 1974, Essentials of food and nutrition, Ganesh and Co.Madras pp.498.

Uchoa, A.M.A., J.M.C. Costa, G.A. Maia, T.R. Meira, P.H.M.I. Sousa, and I. Montenegro. 2009. Formulation and physicochemical and sensorial evaluation of biscuit-type cookies supplemented with fruit powders. Plant Foods Hum. Nutr 64(2):153–159. doi: 10.1007/s11130-009-0118-z.

Wang, R.F., W.D. Xie, Z. Zhang, D.M. Xing, Y. Ding, W. Wang, and L.J. Du. 2004. Bioactive Compounds from the Seeds of Punica granatum (Pomegranate). J. Nat. Products 67(12):2096–2098. doi: 10.1021/np0498051.