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Inclusion of *Rosa damascena Mill.* powder into cookies: nutritional, antioxidant and quality characteristics

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Abstract

This study was designed to investigate the quality characteristics, dietary fibre and antioxidant properties of cookies supplemented with 0-2.5-5-7.5-10% of *Rosa damascena* Mill. powder (RP). Antioxidant activity, total dietary fibre and total phenolic contents increased linearly ($p< 0.01$) by raising the substitution levels of RP whereas water activity, total lipid, total protein contents and fracturability remained almost constant. Cookies became darker and redder with the increasing rate of RP. The use of RP was caused a negligible decrease on spread ratio. Considerable decrease (from 5004. 2 kg to 4469.6 kg for control and 10% RP containing cookies, respectively) on the hardness of cookies was observed after the 5% addition level of RP. The sensory analysis indicated that addition of up to 7.5% RP given was acceptable for cookies without affecting their technological qualities compared with control cookies. Based on overall observations, RP addition to cookies can enhance the nutritional status, especially dietary fibre, total phenolic contents and antioxidant activity without sacrificing consumer acceptability. It was concluded that RF could be added to the formulae to improve the functionality of the cookies as well as other bakery products such as muffins, cakes, bread a few- of acceptable quality.

Key words: Antioxidant activity, cookie, dietary fibre, *Rosa damascene*, sensory acceptance.

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Introduction

Rosa damascene Mill. belonging the to Family Rosaceae and Genus Rosa is called as Isparta Rose or Oil Rose and possess significant economical value (Gül et al., 2015; Dilmen and Baydar, 2016). Turkey has an important place among the rose oil producing countries over the world (Gül, 2000). According to 2018 data, oil rose production quantity of Turkey is 14773 tons and Isparta takes the first place with its 12332 tons production quantity (TUİK, 2018).

Several studies have been performed on the pharmacological effects of R. damascene. Some of these effects can be listed as; good for disorders of the brain and the heart, anticonvulsant effect and could reduce frequency of seizures in children who were resistant to anti-epileptic drugs, used externally for eyes, mouth, foul breath, liver (as plaster), sores, and internally to treat the chest and stomach (Cited by Başer et al., 2012). Rose made tea has been reported to exhibit potent antioxidant activities (Kart and Cağındı, 2017).

Apart from pharmacological uses, rose and rose products are widely used in cosmetic, perfumery and food industries. Fresh or dried rose flowers, rose flower buds, dry rose petals and rose water used as an ingredient for the production of various food products such as rose jam, rose syrup, rose water, herbal teas, traditional Turkish deserts and gluten free cookies(Gül et al., 2010; Başer et al., 2012; Kart and Çağındı, 2017; Gül and Tekeli, 2018).

Bakery products, used as staple foods from ancient times, are an important source of energy in human nutrition. Among bakery products bread takes first and cookies (biscuits) take second range. Production and consumption of cookies are quite high in many countries and also in Turkey, because of their ready-to-eat forms, long shelf life, reasonable prices and practical consumption opportunities (Gül et al., 2016; 2017).

There is an increasing demand for the various novel types of cookies that may provide a health benefits along with the good texture, appearance, flavour and acceptable sensory properties. Thus the lots of additives can be used effectively for producing novel functional cookie varieties.

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Usage of lauric acid-lean copra meal for designing functional antioxidant-rich cookies (Ghosh, et al., 2017), usage of mosambi peel powder to determine its effects on physiochemical and sensory properties of cookies (Younis et al., 2016), functional, physical and sensory properties of cookies prepared from okara, red teff and wheat flours (Ahmed et al., 2018) are of the studies.

Biscuit manufacturers need for tried-and-true cookie recipes to offer innovative and healthier options and to meet increasing demand. However to the best of our knowledge this paper is the first study that investigates the usage of *Rosa damascena* Mill petals powder (RP) in the formulations of soft wheat flour (SWF) cookies. In an effort to increase the nutritional value of common cookies, RP at different substitution levels (0% as control, 2.5%, 5%, 7.5 and 10% w/w) to common SWF were added. Beside nutritional quality, knowledge of effects of different concentrations of RP supplementation on technological and textural quality of cookies is necessary to produce safe, high-quality and value-added cookies. Thus, the goal of the present study is to identify the effect of increasing levels of RP replacement on nutritional (such as dietay fiber, total phenolic content, antioxidant activity, protein, lipid, ash etc.), physical (diameter, thickness, spread ratio, lightness, redness, yellowness), textural (hardness and fracturability) and sensorial properties of SWF cookies.

Materials and Methods

Materials

SWF; had 12.74% moisture, 0.64% ash, 8.5% protein, 20.89% wet gluten, %6.94 dried gluten, 15.5 ml sedimentation value and 355 s falling number values measured by using American Association of Cereal Chemists (ACCC, 2000) methods obtained from Türkmenler Milling Factory (Gaziantep, Turkey). *Rosa damascena* Mill. powder (RP) was purchased from Kurucum Gıda (Isparta Turkey) as vacuum packed after drying and grinding. Moreover, sodium bicarbonate obtained from Şişecam Chemicals Group Soda Industry **(**Mersin, Turkey), 42% corn syrup kindly supplied from Sunar Corn Integrated Plant Inc. (Adana, Turkey) while hydrogenated vegetable oil, granulated sugar, and salt purchased from a local market were used in cookie making. All chemicals used were of analytical grade.

Cookie-Making Procedure

To examine the influence of RP on some nutritional and quality characteristics of cookies, SFW was replaced with RP with 2.5, 5, 7.5 and 10 % levels. Cookie doughs of 100 % wheat flour were prepared as control samples. 225 g wheat flour or wheat flour-RP mixtures (14% moisture basis), 64 g hydrogenated vegetable oil (cream shortening), 130.0 g fine granulated sugar, 2.1 g salt, 2.5 g sodium bicarbonate (NaHCO3), 33 g high fructose corn syrup (42%), and 16.0 g distilled water was used for preparation of cookies according to AACC method 10-50.05 (AACC, 2000) with slight modifications. Cookie dough was kneaded in Hobart mixer, (Hobart, N-50, Germany N-50) and sheeted to a thickness of 5 mm with the help of a rolling pin. Afterwards, the dough was shaped using a circular scone cutter (with a 60 mm diameter) and baked at 205ºC±2◦C for 10 min in a laboratory oven (Fimak FSET4, Turkey). The baked cookies were cooled for 3 h and stored in high-densitypolyethene bags with hermetic cover until further analysis.

Proximate analysis of cookies

Proximate analyses of cookies are important in terms of revealing their nutritional composition. For this purpose standard methods of AACC (AACC, 2000) were used to determine moisture, ash, protein, total lipid, total dietary fibre and pH (AACC Method 44-01.01, AACC Method 08-01.01, AACC Method 46-12.01, AACC Method 30-25.01, AACC Method 32-05.01 and AACC Method 02-52.01 respectively) of cookies. Water activity (Woody, 2003) with an aW - meter (Novasina, Lab Touch-aw, Lachen, Switzerland). Total phenolic content (TPC) and antiradical activity of RF and cookies were detected by using methods of Singleton and Rossi, (1965) and α-diphenyl-β-picrylhydrazyl DPPH method of Dorman et al. (2003).

Physical characteristics of cookies

Width (W), thickness (T), and spread ratio (W/T) parameters of cookies at the end of baking were measured by using digital calliper in mm at five different places in each cookie. For each batch measurements from 6 cookies were recorded and average was calculated. Spread ratio (W/T) was calculated by dividing average W to T for each sample. Surface colors of the cookies were measured in three different zones of the crust using colourimeter (Minolta CR-310, Minolta Co Ltd., Tokyo, Japan). Results were recorded using CIELAB $L*$ (lightness), $a*$ (+redness/−greenness), and $b*$ (+yellowness/−blueness) values.

Textural Properties of Cookies

Cookie break strength and the distance at the point of break "fracturability" values were measured by a TA.XTPlus Texture analyser (Stable Micro Systems, UK) using a 3-Point Bending Rig (HDP/3PB) and 5 kg load cell. Test parameters were performed as; pre-test speed: 1.0 mm/s, test speed: 3.0 mm/s, post-test speed; 10 mm/s, distance: 5.0 mm and data acquisition rate 500 pps. Textural analyses were conducted after 6 h, at 24 °C, in five replicates per batch.

Sensory analysis

Sensory analysis of cookies were carried out by ten untrained judges from food engineering department according to Gül et al. (2013) after 4 hours of baking. The samples were coded with three-digit numbers and were presented in a randomized order. The attributes were estimated on a hedonic scale from 1 to 5 point; 'dislike extremely' to 'like extremely' respectively. The sensory attributes evaluated were surface colour, surface structure, texture (hardness), taste, aroma, odour, overall acceptance and also purchasing intent was determined on a five-point scale (5: definitely would buy, 1: definitely would not buy).

Statistical analysis

Results were expressed as means of analysis performed in triplicate. One way analysis of variance (ANOVA) and Duncan's test was conducted to establish the significance of differences among mean values at $p \leq 0.01$ by using the software, statistical package for social science (SPSS 16.0) procedures.

Results and Discussions

Proximate Composition

Data on the proximate composition of cookies are presented in Table 1. Moisture, protein, pH and aw values increased slightly with the level of substitution of RP while addition of RP was not changed total lipid content of cookies significantly. As can be seen, moisture content of the cookies increased significantly with an increase of RP level to 10%. Increase in the moisture content of cookies with the increase in fibre content was reported by various researchers (Arun et al., 2015; Suriya et al., 2017). This may be due to the higher water absorption and water holding capacity of NPF fibre. The ash content of cookies was began to decrease over 5% supplementation level of RP.

The protein content of the 7.5% and 10% RP containing cookies was significantly higher compared to that of the control cookies. These results are in agreement with the previous studies including cookies prepared from Amorphophallus paeoniifolius flour (Suriya et al., 2017).

A considerable increase was observed on the dietary fibre content of cookies with the increasing level of RP. A significant difference was found between the control sample and the 10% RP containing cookies in terms of dietary fibre content. Previous studies have found similar results, where the addition of baru (Dipteryx alata Vog.) flour (Caetano et al., 2017), or different replacement levels (10-30%) of wheat flour with either watermelon rind powder or hi-maize starch (Naknaen et al., 2016), and papaya pulp flour (Varastegani et al., 2015) in cookies significantly increased the concentration of fibers.

Table 1. Proximate composition of control and RP enriched cookies[1]

RP (%)	Moisture (%)	Ash (%)	Protein (%)	Total lipid (%)	Total dietary fibre (%)	pH	aw	TPC (g/kg GAE)	Antiradical activity (DPPH IC50 mg/ml)
0	6.14^{b}	1.53^{a}	9.65^{c}	15.16^{a}	1.90^{e}	5.90^{b}	0.42^{c}	0.9200^{e}	0.0000
2.5	6.34^{ab}	1.56^{a}	9.71^{bc}	15.38^{a}	3.64^{d}	7.13^{a}	0.44^{b}	59.6700^{d}	0.0000
5	6.91^{ab}	1.54^{a}	9.79^{abc}	15.12^{a}	4.49^{c}	7.10^{a}	0.45^{ab}	103.4138^{c}	7914.1100^{a}
7.5	6.66^{ab}	1.32^{b}	9.87^{ab}	15.29^{a}	5.08^{b}	7.00^{a}	0.45^{a}	126.0313^{b}	6917.9188^{b}
10	7.17^{a}	1.06^{c}	9.95^{a}	15.18^{a}	7.27^{a}	6.93^{a}	0.45^{a}	167.9075^{a}	5793.9075^{c}

[1]: There is no statistically significant difference between the averages indicated by the same letter in the same column ($p<0.01$).

According to the results summarised in Table 1, addition of RP was provided a significant rise on total phenolic content of cookies. While a little phenolic substances (0.92 g/kg GAE) were found in the control sample, this value was increased linearly to 59.6700, 103.4138, 126.0313, g/kg GAE for 2.5%, 5%, 7.5% and 10% RP containing cookies respectively. Our findings are in accordance with Varastegani et al. (2015) that assessed an increase the content of polyphenols in cookies when papaya pulp flour was used as a substitute for normal wheat flour (15, 30 and 50%).

Moreover, antiradical activity (DPPH IC50) of RP added cookies were also found higher than %100 wheat flour cookies (control samples). The results revealed that addition of RP exhibited higher antioxidant properties by rising the substitution levels of SWF with RP. Significant increase at the antioxidant activities of were also stated for cookies enriched with *Codonopsis lanceolata* powder (Song and Lee, 2014), *persimmon leaf* powder (Lim and Lee, 2016), *Taraxacum coreanum* powder (Lee et al., 2017) and Omija (Schizandra chinesis Baillon) extract (Kim et al., 2015) .

Physical and Textural Characteristics

Physical characteristics of cookies prepared with different RP contents are displayed in Table 2. An increase in RP content over the 5% significantly decreased the both W and spread ratio of the cookies whereas it was not caused any significant difference at T values of cookies. These results were in agreement with the results reported by Lim and Lee (2016) found a significant decrease at the spread ratio of cookies with increase in persimmon leaf powder (supplemented with 1-4% levels). Similarly, incorporation of different percentages of mosambi peel powder, 4, 6, 8, 10 and 12%, were resulted in a decrease on the spread ratio of cookies (Younis et al., 2016). Arun et al. (2015) observed a decrease in spread ratio and breaking strength of cookies as the percentage of *Nendran* peel flour increased.

Significant differences ($p<0.01$) were obtained on the colour values of cookies due to addition of RP in to cookie formulation. The higher the replacement of RP, the lower the lightness and yellowness. Cookies were became darker by the addition of RP. However, when comparing $a*$ value, statistically significant difference ($p<0.01$) were found between samples. A linear increase in the $a*$ values were detected with the replacement of RP.

Table 2. Physical and textural characteristics of control and RP enriched cookies[1]

RP (%)	W (mm)	T (mm)	W/T	L∗	a∗	b∗	Hardness (kg)	Fracturability (mm)
0	61.85^{a}	9.50^{a}	6.51^{a}	65.96^{a}	4.45^{d}	22.09^{a}	5004.2^{a}	40.07^{a}
2.5	62.56^{a}	9.59^{a}	6.52^{a}	47.38^{b}	8.22^{c}	11.73^{b}	5246.5^{a}	40.16^{a}
5	62.62^{a}	9.57^{a}	6.54^{a}	41.52^{c}	9.30^{b}	7.87^{c}	5284.5^{a}	40.30^{a}
7.5	61.10^{b}	9.57^{a}	6.38^{b}	38.63^{d}	9.59^{b}	6.81^{d}	4791.8^{b}	39.78^{a}
10	60.75^{c}	9.57^{a}	6.35^{b}	35.71^{e}	10.25^{a}	5.58^{e}	4469.6^{c}	40.07^{a}

(1): There is no statistically significant difference between the averages indicated by the same letter in the same column ($p<0.01$). W: Width, T: Thickness, W/T: Spread ratio, L:Lightness, a:redness, b:yellowness

Textural properties of cookies are the important criteria for the evaluation of cookie quality. Hardness and fracturability values of control and RP added cookies are presented in Table 2. Hardness- peak force to break the cookie- was not showed any significant change up to 5% RP content whereas hardness of 7.5% and 10% containing cookies decreased gradually. This decrease was probably arisen from both higher moisture and aw values of cookies, prepared from higher concentrations of RP. On the other hand the fracturability was generally not affected from the supplementation of RP. In contrast to our findings some researchers (Song and Lee, 2014; Lim and Lee, 2016; Younis et al., 2016) observed an increase on the hardness of cookies supplemented with different fibre sources. The reason for these contradictions may be due to differences in the particle size, water absorption capacity and solubility of fibres studied (Mancebo et al., 2018).

Sensory Evaluation

Sensory scores of cookies prepared from different concentrations of RP can be seen from Figure 1. Surface colour of 10% RP containing cookies were approved the highest score while other RP containing cookies were scored less than control cookies. Darker colour of 10%RP cookies may be considered as the reason of higher scores them. Color of foods is an important quality characteristics and major factors affecting sensory perception and consumer acceptance of them. It is a powerful marketing tool that influences consumer purchases in many aspects (Kumar, 2017). There is a tendency among consumers to buy darker bakery products because they think that when the colour of a product is darker the healthier it is and also it has higher dietary fibre content. In recent decades with the recognition of the importance of dietary fiber there is an increase interest in bakery products with high fiber content (Krolak et al., 2017). Along with the surface colour surface structure of the cookies enriched with RP was scored higher compared with control cookies. This value of the investigated cookies was showed a significant ($p<0.01$) gradual increase up to 7.5 % addition level of RP.

The consumer acceptance test indicated that addition of RP had a favourable effect on hardness of cookies. The hardness values of cookies were decreased despite the increasing RP level as determined in the instrumental measurements. The addition of RP in the formulation had positive effects on the taste, aroma and odour as compared to the control samples. Among RP containing cookies 7.5% RP cookies were preferred most than other levels of RP in terms of overall acceptance, purchasing intent, taste, aroma, odour and surface structure (Figure 1).

Higher usage levels of fiber in cookies, effects their acceptability inversely. Curutchet et al. (2019) reported that, although labels of cookies enriched with antioxidant fibre using a blueberry pomace by-product were taken higher liking scores than reference vanilla cookie, consumers did not like it when they tasted and the information on its label did not significantly increase acceptability. Similarly, Lee et al. (2017), Lim and Lee (2016) indicated that, respectively addition of *Taraxacum coreanum* powder and persimmon leaf powder at a concentration of up to 2% had a favorable effect on consumer preferences.

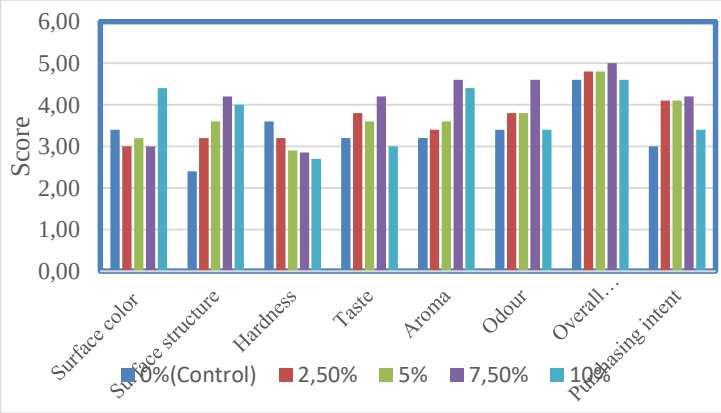

Figure 1. Sensory assessment of cookies

Conclusions

The purpose of this study was to formulate functional cookies that exhibit an acceptable sensorial and technological quality attributes by partial replacement of SWF with RP in different levels. According to the proximate compositions of cookies enriched with RP at different concentrations revealed that the addition of RP provides an important nutritional advantage to cookies with regard to high fiber, total phenolic content and also high antioxidant activity.

Based on physical properties, partial replacement of SWF with RP over to 5% level reduced the diameter and spread ratio of cookies but did not affect the thickness. Cookies became darker and softer linearly with the increasing level of RP in formulation. Regarding the sensory scores, the samples with RP exhibited acceptable sensory attributes. According overall acceptability and purchasing intent scores cookies containing up to 7.5% RP can be produced without sacrificing consumer acceptability. However, the use of RP makes these cookies functional foods because of their good nutritional content.

The results indicate that Rosa damascena Mill powder (RP) can be used as a functional ingredient in bakery products such as cookies, muffins, cakes, bread a few- of acceptable quality.

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