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Original research

An investigation on the possibility of production of cookie containing sunflower seed meal flour and *Rosa damascena* waste extract

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ABSTRACT

In recent years, the production of nutritious snacks has received much attention. Food industry by-products represent an abundant source of nutrients and are often used as an animal feed. Sunflower seed meal is high in protein and essential amino acids, minerals and vitamins and mohammadi rose (*R. Damascena*) waste, contains high amounts of phenolic compounds. In the present study, sunflower seed meal flour (SSMF) at 15% and 20% (w/w) was substituted with wheat flour and mohammadi rose flower waste extract (MFWE) at (1 and 2%) were used in cookie formulation and chemical tests, antioxidant activity, sensory and optical properties of the samples were measured at 0, 10 and 20 day intervals. The results showed that the amount of ash, protein, fat and fiber of cookie samples were in the ranges of (1.84-3.55%), (10.41-15.45%), (16.49-18.45%) and (2.04-2.32%) respectively. The addition of SSMF led to a significant increase in ash, protein, fat, total fiber of the samples ($p \leq 0.05$). Adding the MFWE did not result in a significant difference in the amount of ash, protein, fat, and pH of the samples ($p > 0.05$). Addition of SSMF and MFWE increased the moisture content, antioxidant activity and yellowness (b*) and decreased the peroxide value and lightness (L*) of the samples ($p \leq 0.05$). In all intervals, treatment 5 (cookie containing 0% SSMF and 2% MFWE) and treatment 6 (cookie containing 15% SSMF and 1% MFWE) had overal acceptance scores and sample 5 (cookie containing 0% SSMF and 2% MFWE) was selected as the best treatment.

Keywords: By-products, Cookie, Mohammadi rose flower, Sunflower meal

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1. Introduction

One of the most important goals of the food industry is to design a variety of nutritious snacks that can providing a good supply of protein, vitamins and minerals, also have health effects. (Pestoric et al., 2017). In recent years, the cookie industry has been developing rapidly around the world. Improving the quality characteristics and nutritional value of such snacks can be effective in improving the health of people in the community (Perez et al., 2017). In general, cookies refer to products that contain the three main components of soft wheat flour, sugar and fat along with ingredients such as milk, salt, flavoring agents and bulking agents. The moisture content of the cookie is low (Devi & Khakar, 2016) and the ingredients of its formulation include 30 to 60% fat, 20 to 75% sugar and 7 to 20% water based on the flour used (Jan et al., 2017). In recent years, the use of by-products in food production has increased and is expanding. Most factory wastes contain valuable compounds that their use, in addition to the environmental aspect, can pave the way for the use of their beneficial compounds. Sunflower (*Helianthus annuus* L.) is one of the three most important crops grown in the world (Gunstone et al., 2011) and the most important by-product of sunflower oil extraction, which can make up to 36% of the mass of processed seeds (Gunstone et al., 2011), has a high protein content (40-50%) (Shahidi & Williams, 2005) and is mostly used in animal feed (Gunstone et al., 2011). Sunflower cake or meal contains essential amino acids (lysine, methionine, cystine, tryptophan), a valuable source of calcium, phosphorus and water-soluble vitamins (B-complex, especially nicotinic acid, thiamine, pantothenic acid, riboflavin) (Gunstone et al., 2011) and also has high antioxidant activity (Schmidt et al., 2005). Sunflower meal, unlike other oilseeds such as soybean, rapeseed or cotton, has low anti-nutritional properties (Grompone, 2005). Some limitations of sunflower meal consumption are high levels of insoluble fiber, residual solvents used in oil extraction (Schmidt et al., 2005) and the presence of compounds such as protease inhibitors, saponins and arginase inhibitors (Matthäus et

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al., 2002). Recently, high-pressure and high-temperature steaming in many substrates and by-products were used with the aim of breaking down insoluble fiber into soluble fiber with smaller units (Zhang et al., 2016; Jung et al., 2019) and with the aim of decomposing some compounds. A sterilization method has also been used to decompose some anti-nutritional compounds (Planetarians et al., 2019). Plant wastes are a good source of polyphenolic compounds that can be used in food formulations. Mohammadi flower with the scientific name of *Rosa damascene* Mill is one of the most important species in the production of rose perfume, whose medicinal properties are attributed to the abundance of their phenolic compounds. Phenolic compounds have many medicinal properties such as antioxidant, anti-inflammatory, anti-mutagenic and anti-depressant (kanzkan, 2009). Various compounds have been isolated from the flowers, petals, and fruits of mohammadi rose flower, including terpenes, glycosides, flavonoids, and anthocyanins. The plant also contains carboxylic acid, myrsone, vitamin C, kaempferol and quercetin (Kodouri et al., 2007). More than 3000 kg of fresh rose petals produce about 1 kg of rose oil and 1 kg of fresh raw material, about 2 kg of residue or pulp based on wet weight, thousands of tons of material as waste it is obtained annually from the distillation process that the production units simply dispose of these wastes or biomass obtained from the distillation process as waste in any nearby place (Schieber et al., 2005; Slavov et al., 2017) or is sometimes used as fuel or compost after drying (kanzkan et al., 2014). Hence, large amounts of rose petal distillation residues are not fully utilized (Soliman & Badeaa, 2002). The use of mohammadi rose waste in food products leads to a reduction in pulp and the production of useful by-products (Nedkov, 2005; Slavov et al., 2017). In the research of Kanzkan et al. (2004) the antioxidant activity (IC_{50}) of rose extract was expressed 372.26 mg/g. Grasso *et al*. (2019) in the study of effect of adding sunflower seed flour (18% and 36%) in biscuits, stated that by adding sunflower seed flour, the amount of total protein and phenol and antioxidant properties of the samples increased significantly. Also, with increasing levels of sunflower meal flour, the samples were darker and had less redness and yellowness, while their texture hardness increased. Man et al. (2017) in a study on the effect of adding sunflower flour on the chemical and sensory properties of cracker biscuits, stated that according to the results of sensory tests, replacing sunflower flour up to 35% with wheat flour was quite acceptable and had a significant improvement in chemical compounds (ash, fat and crude protein). Puraikalan (2012) in the study of the effect of adding different percentages of sunflower meal powder on the sensory properties of the cookie stated that the sample containing 20% of sunflower meal powder had a higher overall acceptance score and the product had a very good consumer market due to its low carbohydrate content, high protein, high fiber and has a good content of minerals and vitamins. Due to the importance of using food industry by-products and on the other hand because of high protein and fiber content also presence of essential amino acids, minerals and vitamins in sunflower seed meal and high content of phenolic compounds in mohammadi rose flower waste, the aim of this study was to investigate the possibility of production of cookie containing sunflower seed meal flour and mohammadi rose waste extract.

2. Material and Methods

2.1. Materials

In the present study, sunflower meal, the rest of the extraction of virgin sunflower oil (extracted from sunflower seeds without shells) was purchased from Khavardasht Company (Golestan, Iran) and mohammadi rose flower waste was prepared from Iran gloab componay (Kashan, Iran). All of the chemicals used in this work were purchased from Merck (Germany) company. The chemicals were analytical degree.

2.2. Preparation of raw materials

2.2.1. Preparation of sunflower seed meal flour

In the present study, with the aim of decomposing some anti-nutritional compounds, breaking down insoluble fiber into soluble fibers, and sterilizing sunflower meal, instead of method of Gu et al. (2011), who used the steam explosion on rapeseed meal, Autoclaving method was performed for 15 min at 121°C. The samples were then dried at 60°C overnight and then ground and stored in polyethylene packaging at 4°C until use (Planetarians et al., 2019).

2.2.2. Preparation of mohammadi rose waste extract

After receiving the samples, the pulp was cleaned of impurities (leaves, thorns and other parts other than the petals of the plant) and dried in an electric oven for further storage. The mohammadi rose flower waste was initially dewatered using a filter press and then residuals dried in an oven at 50°C until the water content of them reached 5 to 6% and finally stored at -18°C. Water-ethanol (70:30) solvent (500 cc) was poured into a rotary apparatus to prepare the extracts using the water-ethanol method. Then, dried mohammadi rose waste was powdered and placed into the rotary device. Extraction was carried out for 6 hours through which the siphon operation was conducted 21 times. The extraction operation was continued for 6 hours and the siphon operation was performed 21 times. The aqueous ethanolic extract was separated by vacuum rotary at a temperature of 60-70°C for one hour and finally placed in a glass jar in the refrigerator and frozen (Niafard, 2017).

2.3. SSMF and MRFWE tests

2.3.1. Total phenol

To determine the total phenol, first methanol was added to SSMF. The mixture was then exposed to ultrasonics three times, each time for 15 min with a 10 min pause between the two ultrasounds. The mixture was then centrifuged at 1008 g for 15 min. For mohammadi rose flower waste extract, methanol was added directly to extract. Samples of each treatment were stored in brown vials at -76 °C. Gallic acid was used to draw the standard curve using the extraction solvent (100% methanol). 20 µl of the diluted extract, or standard gallic acid, was thoroughly combined with 100 µl folin-ciocalteu reagent. After 6 min, sodium carbonate was added and thoroughly combined. The mixture is placed at room temperature for 2 hours and finally the absorbance was read by a spectrophotometer at a wavelength of 760 nm. The results were expressed in µg of gallic acid per gram of dry matter (Vasantha Rupasinghe et al., 2008).

2.3.2. Antioxidant activity

For this purpose, solutions with different concentrations (50, 75, 100, 250 and 500 µg/ml) of the extract as well as synthetic antioxidant BHT (Butylated Hydroxy Toluene) in methanol was prepared. One ml of DPPH methanolic solution (was added to 3 ml of the extract and the resulting mixture was stirred vigorously). The test tubes are placed in a dark place for 30 min and percentage inhibition of free radicals was determined by measuring the absorbance of extract at 517 nm. It should be noted that in the control sample, the extract is replaced with 3 ml of methanol. Finally, the percentage of inhibition of radicals by the extract was calculated by Eq. 1. In this regard, A_s and A_c are the control absorbance and sample absorbance, respectively.

$$\text{Free radical inhibition} = \frac{A_c - A_s}{A_c} \times 100 \quad (1)$$

2.3.3. Total fiber

This test was performed according to AACC method No. 10-32 (Anonymous. 2003). In the first the sample was degreased with petroleum ether and then sulfuric acid was added to the fat-free sample. The boiling was performed for 30 min, the acid was drained by vacuum. Sodium solution was added again to the material inside the crucible and boiled for 30 min and then the resulting mixture was drained under vacuum. The material inside the crucible was then washed several times with water and finally the crucible was placed at 100°C until it reached a constant weight. After weighing the crucible, it was placed in an oven at 550°C and turned to ashes. After cooling, the crucible is weighed and the amount of fiber is obtained using Eq. 2.

$$\text{Total fiber} = \frac{W_2 - W_1}{m} \times 100 \quad (2)$$

In this regard, W_2 is the weight of the crucible containing the sample after drying in hot air oven and W_1 is the weight of the crucible containing the ash after incineration and m is the weight of the sample.

2.4. Preparation and baking of cookie samples

Cookies were prepared using the American Association of Cereal Chemists (AACC) method 10–54, with some modifications. Appropriate amounts of dry matter, 71.2 g granulated sugar, 16 g brown sugar, 2 g salt, 1.6 g sodium bicarbonate and 1.6 g skimmed milk powder were accurately weighed and mixed to give a uniform mixture. 64 g Shortening and dry matter were added to the mixer continer and mixed on low speed for 3 min. 2.4 g of honey dissolved in 35.2 g of water and 2 g of vanilla extract were added to the creamed mass into the mixing bowl. The resulting mass was mixed for 1 min and finally 160 g of flour was added and mixed at low speed for 1 min (Anonymous, 2000). The wheat flour in the cookie formula was replaced by SSMF and MFWE in 8 different levels presented in Table 1. The dough produced by special rollers was spread to a thickness of 7 mm and divided into small circles with a diameter of 6 cm by a mold. The dough slices were immediately baked in the oven at an average temperature of 204°C for 8 min. After leaving the oven, the baked cookies were cooled to room temperature for 20 min and finally packaged and stored at room temperature until the time of testing.

2.5. Chemical tests of wheat flour and cookie samples

Ash according to AACC method No. 01-08, moisture according to AACC method No. 16-44, protein according to AACC method No. 12-64, fat according to AACC method No. 25-30 and Soxhlet method, pH according to AACC method No. 16-14 was measured (Anonymous, 2003).

Table 1. Introducing treatments used in this research.

Treatments	Description
Code (1)	Control sample (cookie without SSMF and MFWE)
Code (2)	Cookie contains 15% SSMF and 0% MFWE
Code (3)	Cookie contains 20% SSMF and 0% MFWE
Code (4)	Cookie contains 0% SSMF and 1% MFWE
Code (5)	Cookie ontains 0% SSMF and 2% MFWE
Code (6)	Cookie contains 15% SSMF and 1% MFWE
Code (7)	Cookie contains 20% SSMF and 1% MFWE
Code (8)	Cookie contains 15% SSMF and 2% MFWE
Code (9)	Cookie contains 20% SSMF and 2% MFWE

*SSMF: Sunflower seed meal flour, MFWE: Mohammadi rose flower waste.

2.6. Antioxidant activity

The cookie sample extract containing SSPS and MFWE was prepared in three stages. First, the samples were dried in a vacuum oven at 40°C. Second, they were degreased using a hot plate and hexane solvent at 35°C for 4 h. Third, the extraction was carried out using a methanol solution on a magnetic stirrer (1 g) at 25°C for 24 h. Finally, the resulting sample was concentrated using a rotary device at 40°C. Antioxidant activity or percentage of free radical scavenging of extracts from cookie samples, as mentioned above for SSPS and MFWE, using free radical scavenging 1, 1, diphenyl-2-picryl Hydrazyl (DPPH) was measured on days 0, 10 and 20 days after production (Azarhoosh, 2017).

2.7. Extractive fat peroxide value

First, 100 g of the sample was crushed in a complete mechanical stirrer and 500 ml of N-hexane was added to it and mixed well. It was stationary for a while until the solvent phase became clear. The clarified solvent phase was evaporated using a rotary apparatus. Then, a mixture of acetic acid and chloroform was added to the extracted fat, then saturated potassium iodide solution was placed in a dark medium for one min, and finally distilled water was added to it and calibrated with sodium thiosulfate solution until becomes yellow. A few drops of starch detector were added and the solution was shaken vigorously and the calibration was continued until the blue color disappeared. At the end of the operation, after adding each drop of sodium thiosulfate was shaken vigorously (National Standard No. 37, 2015). The peroxide number was calculated according to Eq. 3.

$$\text{Peroxide value} = \frac{V \times N \times 1000}{m} \quad (3)$$

V = volume of sodium thiosulfate solution used in the experiment, m = fat weight in grams, N = normality of sodium thiosulfate solution consumed, 1000 = unit conversion factor per gram, peroxide value = in milliequivalents per kilogram.

Table 2. Comparison of chemical properties of flour and SSMF.

Sample	pH	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fiber (%)
Flour	6.90±0.06[a]	1.20±0.09[c]	11.50±0.04[b]	2.50±0.04[b]	0.89±0.02[b]	0.80±0.03[b]
SSMF	6.80±0.04[c]	4.50±0.05[b]	34.41±0.14[a]	11.98±0.08[a]	6.28±0.06[a]	22.00±0.09[a]
MFWE	6.86±0.04[a]	10.70±0.05[a]	8.63±0.14[a]	7.30±0.08[a]	1.39±0.06[a]	15.91±0.09[a]

Different small letters in a column have a significant difference ($p < 0.05$).

2.8. Instrumental color measurement

The color determination test of cookie samples was performed by Hunterlab colorimeter according to AACC method No. 01/22-14. By specifying the color indices a*, b* and L*, the color parameter of the cookie samples was determined (Anonmyous, 2003). The L*value indicates the brightness and opacity of the samples, a* value indicates red or green of the samples and b*value indicates yellow or blue of the samples. Colorimetric test was performed on the samples on the day of production.

2.9. Organoleptic properties of cookie samples

Sensory properties of cookie samples including taste, texture, odor, color and general acceptance were performed in a 5-point hedonic test. In the evaluation form, 5 levels (excellent, good, average, poor and very poor) were considered. Samples were prepared in one day and examined by 8 trained evaluators (It should be noted that a group of trained panels consists of 3 men and 5 women and they were in the age range of 30-39 years) (Baumgartner et al., 2018). Sensory evaluation of the samples was performed on the samples at 0, 10 and 20 days after production.

2.10. Statistical analysis

All experiments were performed in triplicate, and the mean values and standard deviations were reported. The experimental data were statistically analyzed using one-way analysis of variance (ANOVA) to determine the significant differences between different formulations at 95% confidence level. Duncan's multiple range test ($p < 0.05$) was used to determine significant differences between the means. All statistical analyses were conducted using SPSS v. 16 (IBM, NY, USA).

Table 3. Comparison of total phenol and antioxidant activity (IC_{50}) of SSMF and MFWE.

Sample	Total phenol (mg/g)	Antioxidant activity (mg/ml)
SSMF	13.67±0.07[b]	0.324±0.09[a]
MFWE	15.19±0.11[a]	0.143±0.05[b]

Different small letters in a column have a significant difference ($p < 0.05$).

3. Results and Discussion

3.1. Results of tests performed on flour, SSMF and MRFWE

Comparison of chemical properties of flour and SSMF (Table 2) showed that the amount of ash, protein, fat and fiber of SSMF was 6.28, 34.41, 11.98 and 22, respectively, and compared to flour, it has higher amounts of protein, fat, ash and fiber. Man et al. (2017) in the study of the effect of adding sunflower flour on the chemical and sensory properties of cracker biscuits, reported that the amount of ash, protein and fat of sunflower flour were 4.39, 22.30, 37.03%, respectively. In some scientific reports, the total fat content of sunflower seed flour is between 26.47 - 58.58% and its total protein is between 17.18 - 26.89%. (Nadeem et al., 2010). Tarek-Tilistyák et al. (2014) in the study of the composition and energy density of sunflower seed, stated that its ash, fat and protein content were 7, 9.1 and 5%, respectively. Aishwarya et al. (2014) in studying the nutritional composition of sunflower flour and the nutritional value of products prepared with sunflower flour, stated that the moisture content of sunflower seed flour was 3.1, ash 4.49, carbohydrates 18.18, protein 19.19 and fat 53%. Also, Calcium, phosphorus and iron were 277 (mg/100g), 667.66 (mg/100g) and 9.4 (mg/100g), respectively. Comparison of total phenol and antioxidant activity (IC_{50}) of SSMF and MFWE (Table 3) showed that the amount of total phenol and antioxidant activity of MFWE was significantly higher than SSMF ($p \leq 0.05$). According to researchers' findings, sunflower seeds are a rich source of phenolic compounds, and the total phenol content of sunflower seeds is estimated at about 10-42 (g/kg) (De Leonardis et al., 2003). The phenolic content of sunflower meal is reported to be equal to that of sunflower seeds and is highly dependent on the amount of husk as well as the sunflower variety used (Weisz et al., 2009). The phenolic compounds of sunflower oil extraction by-products are such that they can be recovered and used as a natural antioxidant in other products (Weisz et al., 2009). Caffeic acid and chlorogenic acid make up 70% of the phenolic compounds in sunflower seeds (Sabir et al., 1976).

Kumar et al. (2009) in the study of antioxidant activity of methanolic extracts of 3 species of fresh roses (including *Rose damascena, Rose bourboniana, Rose brunonii*) by DPPH free radical method, stated that methanolic extract of Rose brunonii species has maximum free radical scavenging activity (64.5%) and then *Rose bourboniana* (51.8%) and finally *Rose damascena* (43.6%) at 100 µg/ml (Kumar et al., 2009).

3.2. Results of tests performed on cookies containing SSMF and MRFWE

3.2.1. Protein

Chemical properties of cookie samples (Table 4) showed that the protein content of cookie samples ranged from 10.41% to 15.45% and the addition of SSMF increased the protein content of the samples compared to the control sample ($p \leq 0.05$). But adding the MFWE did not result in a significant difference in the amount of protein content of the samples ($p > 0.05$). Considering the amount of protein in SSMF (34.41%) and amount of protein in used flour (11.50%), increasing the protein content of cookies by increasing the amount of SSMF was not unexpected. The lowest amount of protein in the control sample and samples 4 (cookies containing 0% SSMF and 1% MFWE) and 5 (cookies containing

0% SSMF and 2% MFWE) who did not have SSMF, was observed ($p \leq 0.05$). Also the highest amount of protein in treatments 3 (cookies containing 20% SSMF and 0% MFWE), 7 (cookies containing 20% SSMF and 1% MFWE) and 9 (cookies containing 20% of SSMF and 2% of MFWE) were observed to contain the highest amount of SSMF ($p \leq 0.05$). Since sunflower seed proteins are rich in essential amino acids (lysine, threonine, and valine), and grain proteins are deficient in the amino acid lysine but contain sufficient amounts of the sulfur amino acid, the combination of wheat and sunflower seed proteins can Provide the balance of essential amino acids (Man et al., 2017). The results of the present study were in line with the findings of Man et al. (2017), which in examining the effect of adding sunflower flour on the chemical and sensory properties of cracker biscuits, stated that with increasing the amount of sunflower flour, the protein content of the samples significantly Increased. The results of the present study were in line with the results of Grassok et al. (2019) study on the effect of adding sunflower seed flour at levels of 18 and 36% by weight on biscuits, which acknowledged the fat content of SSMF. The protein content of the samples increased significantly. Sambucetti et al. (1976) also investigated the effect of fortifying wheat flour with soybean meal and SSMF, stating that the protein content of fortified biscuits increased by up to 60% compared to the control group. Alimi et al. (2014) in investigating the effect of adding evening primrose meal in sponge cake formulation stated that increasing the amount of meal increased the protein of the samples. Aishwarya (2014) in a study of the nutritional composition of sunflower flour and the nutritional value of products prepared with sunflower flour, acknowledged that by increasing the amount of sunflower flour, the protein content of the samples increased significantly.

3.2.2. Fat

In the present study, the fat content of cookie samples ranged from 16.49 to 18.45%. The results of the present study showed that the addition of SSMF increased the fat content of the samples compared to the control sample ($p \leq 0.05$). But adding the MFWE did not result in a significant difference in the amount of fat content of the samples ($p > 0.05$). Considering the fat content of SSMF (11.98%) and the fat content of used flour (2.50%), increasing the fat content of cookies by increasing the amount of SSMF was not unexpected. The lowest fat content in the control sample and samples 4 (cookie containing 0% SSMF and 1% MFWE) and 5 (cookie containing 0% SSMF and 2% MFWE) who did not have SSMF was observed ($p \leq 0.05$).

Table 4. Chemical properties of cookie samples containing different amounts of SSMF and MFWE on the day of cooking.

Treatments	Ash (%)	Fat (%)	Protein (%)	Fiber (%)	pH
Code (1)	1.84 ± 0.04^{c}	16.49 ± 0.39^{c}	10.41 ± 0.07^{c}	2.04 ± 0.07^{i}	6.92 ± 0.14^{ab}
Code (2)	2.74 ± 0.04^{b}	17.26 ± 0.16^{b}	14.00 ± 0.12^{b}	5.16 ± 0.12^{f}	6.90 ± 0.04^{bc}
Code (3)	2.96 ± 0.06^{a}	18.19 ± 0.21^{a}	15.50 ± 0.10^{a}	6.00 ± 0.10^{c}	6.89 ± 0.08^{c}
Code (4)	1.78 ± 0.03^{c}	16.39 ± 0.31^{c}	10.41 ± 0.14^{c}	2.19 ± 0.14^{h}	6.92 ± 0.09^{a}
Code (5)	1.76 ± 0.02^{c}	16.57 ± 0.38^{c}	10.45 ± 0.07^{c}	2.32 ± 0.07^{g}	6.90 ± 0.06^{ab}
Code (6)	2.75 ± 0.13^{b}	17.16 ± 0.14^{b}	13.95 ± 0.07^{b}	5.29 ± 0.07^{e}	6.67 ± 0.02^{bc}
Code (7)	2.97 ± 0.04^{a}	18.24 ± 0.10^{a}	15.50 ± 0.12^{a}	6.17 ± 0.12^{b}	6.89 ± 0.07^{c}
Code (8)	2.83 ± 0.08^{b}	17.30 ± 0.07^{b}	14.00 ± 0.12^{b}	5.53 ± 0.12^{d}	6.90 ± 0.03^{c}
Code (9)	3.05 ± 0.04^{a}	18.35 ± 0.16^{a}	15.45 ± 0.07^{a}	6.32 ± 0.07^{a}	6.89 ± 0.05^{c}

Different small letters in a column have a significant difference ($p < 0.05$).
Code (1): Control sample (Cookie without SSMF and MFWE), Code (2): Cookie containing 15% SSMF and 0% MFWE, Code (3): Cookie containing 20% SSMFand 0% MFWE, Code (4): Cookies containing 0% SSMF and 1% MFWE, Code (5): Cookies containing 0% SSMF and 2% MFWE, Code (6): Cookie containing 15% SSMF and 1% MFWE, Code (7): Cookie containing 20% SSMF and 1% MFWE, Code (8): Cookies containing 15% SSMF and 2% MFWE, Code (9): Cookies containing 20% SSMF and 2% MFWE.

Table 5. Moisture content of cookie samples containing different amounts of SSMF and MFWE during storage (%).

	Storage time (days)		
Treatments	Day 1	Day 10	Day 20
Code (1)	5.77 ± 0.14^{fA}	4.15 ± 0.09^{eB}	3.80 ± 0.07^{fC}
Code (2)	7.67 ± 0.04^{cdA}	5.86 ± 0.16^{dB}	5.03 ± 0.12^{deB}
Code (3)	7.86 ± 0.08^{cdA}	5.97 ± 0.21^{dB}	5.81 ± 0.10^{cB}
Code (4)	6.86 ± 0.09^{eA}	5.65 ± 0.01^{dB}	4.62 ± 0.14^{eC}
Code (5)	7.50 ± 0.06^{dA}	5.73 ± 0.02^{dB}	5.53 ± 0.07^{cdB}
Code (6)	7.67 ± 0.18^{cdA}	6.81 ± 0.14^{cB}	6.21 ± 0.07^{bcB}
Code (7)	8.89 ± 0.17^{bA}	7.50 ± 0.12^{bB}	6.69 ± 0.12^{abC}
Code (8)	8.11 ± 0.13^{cA}	7.56 ± 0.17^{bB}	6.86 ± 0.12^{abC}
Code (9)	10.06 ± 0.85^{aA}	8.37 ± 0.15^{aB}	7.17 ± 0.07^{aC}

Different small letters have a significant difference in the column and different capital letters have a significant difference in the row ($p < 0.05$).
Code (1): Control sample (Cookie without SSMF and MFWE), Code (2): Cookie containing 15% SSMF and 0% MFWE, Code (3): Cookie containing 20% SSMFand 0% MFWE, Code (4): Cookies containing 0% SSMF and 1% MFWE, Code (5): Cookies containing 0% SSMF and 2% MFWE, Code (6): Cookie containing 15% SSMF and 1% MFWE, Code (7): Cookie containing 20% SSMF and 1% MFWE, Code (8): Cookies containing 15% SSMF and 2% MFWE, Code (9): Cookies containing 20% SSMF and 2% MFWE.

Also the highest amount of fat in samples 3 (cookies containing 20% SSMF and 0% MFWE), 7 (cookies containing 20% SSMF and 1% MFWE) and 9 (cookies containing 20% of SSMF and 2% of MFWE) were observed to contain the highest amount of sunflower meal ($p \leq 0.05$). Man et al. (2017) in the study of the effect of adding sunflower flour on the chemical and sensory properties of cracker biscuits stated that with increasing the amount of sunflower flour, the fat content of the samples increased significantly. In general, it can be said that by increasing the amount of fat due to the addition of sunflower meal flour, it is beneficial for human health because approximately 90% of the fat of sunflower seeds is unsaturated fat and contains tocopherol as a natural antioxidant. Tocopherols are believed to reduce the incidence of diseases such as cancer and cardiovascular disease (Adams & Best, 2002). Aishwarya (2014) in a study of the nutritional composition of sunflower flour and its nutritional value Products prepared with sunflower flour acknowledged that by increasing the amount of sunflower flour, the fat content of the samples increased significantly.

3.2.3. Total fiber

The results of the present study showed that the total fiber content of cookie samples ranged from 2.04 to 6.32% and the addition of SSMF and MFWE increased the total fiber of the samples compared to the control sample ($p \leq 0.05$). Increasing the amounts of MFWE and SSMF led to a significant increase in total fiber of the samples ($p \leq 0.05$). Considering the amount of total fiber of SSMF (22.49%), MFWE (15.91%) and used flour (0.80%), the increase in the amount of total fiber of cookies by increasing the amount of SSMF and MFWE was not unexpected. The lowest amount of total fiber was observed in the control sample and the highest amount of total fiber was observed in sample 9 (cookie containing 20% SSMF and 2% MFWE) ($p \leq 0.05$). Regarding the effect of MFWE on increasing the total fiber of the samples, it is possible that small molecule insoluble fibers, such as lignin and hemicellulose have also entered the extract and have been able to increase the total fiber of the samples compared to the control sample. Alimi et al. (2014) in investigating the effect of adding evening primrose meal in sponge cake formulation stated that increasing the amount of meal increased the total fiber of the samples. Tavan et al. (2017) in investigating the effect of sesame meal on some physicochemical and sensory properties of barbari bread, stated that the addition of sesame meal significantly increased the fiber content of bread.

Table 6. Antioxidant activity (IC_{50}) of cookie samples containing different amounts of SSMF and MFWE during storage (mg/ml).

	Storage time (days)		
Treatments	Day 1	Day 10	Day 20
Code (1)	17.77 ± 0.78^{aA}	24.73 ± 0.69^{aB}	39.51 ± 0.07^{aC}
Code (2)	14.33 ± 0.31^{bA}	15.72 ± 0.16^{bB}	26.02 ± 0.12^{bB}
Code (3)	12.89 ± 0.22^{cA}	14.86 ± 0.21^{cB}	18.39 ± 0.10^{cB}
Code (4)	10.55 ± 0.19^{dA}	14.86 ± 0.11^{cB}	16.54 ± 0.14^{dC}
Code (5)	7.93 ± 0.06^{fA}	9.51 ± 0.22^{eB}	10.36 ± 0.07^{fB}
Code (6)	10.02 ± 0.18^{deA}	12.87 ± 0.14^{dB}	14.20 ± 0.07^{eB}
Code (7)	9.50 ± 0.17^{eA}	12.23 ± 0.12^{dB}	12.71 ± 0.12^{eC}
Code (8)	7.44 ± 0.13^{fgA}	9.91 ± 0.17^{efB}	9.29 ± 0.09^{fC}
Code (9)	7.05 ± 0.85^{gA}	8.38 ± 0.15^{fB}	8.57 ± 0.14^{fC}

Different small letters have a significant difference in the column and different Capital letters have a significant difference in the row ($p < 0.05$).
Code (1): Control sample (Cookie without SSMF and MFWE), Code (2): Cookie containing 15% SSMF and 0% MFWE, Code (3): Cookie containing 20% SSMFand 0% MFWE, Code (4): Cookies containing 0% SSMF and 1% MFWE, Code (5): Cookies containing 0% SSMF and 2% MFWE, Code (6): Cookie containing 15% SSMF and 1% MFWE, Code (7): Cookie containing 20% SSMF and 1% MFWE, Code (8): Cookies containing 15% SSMF and 2% MFWE, Code (9): Cookies containing 20% SSMF and 2% MFWE.

Table 7. Peroxide value of cookie samples containing different amounts of SSMF and MFWE during storage (meq/kg).

	Storage time (days)		
Treatments	Day 1	Day 10	Day 20
Code (1)	2.97 ± 0.01^{abA}	5.78 ± 0.09^{aB}	5.98 ± 0.07^{aC}
Code (2)	2.96 ± 0.01^{abA}	5.12 ± 0.16^{bB}	5.53 ± 0.12^{bB}
Code (3)	2.97 ± 0.02^{abA}	4.42 ± 0.21^{deB}	4.96 ± 0.10^{cdB}
Code (4)	2.99 ± 0.01^{abA}	4.56 ± 0.01^{cdB}	5.18 ± 0.14^{bcC}
Code (5)	2.94 ± 0.01^{bA}	3.62 ± 0.02^{fB}	4.51 ± 0.22^{eB}
Code (6)	2.95 ± 0.02^{abA}	4.73 ± 0.14^{cB}	4.70 ± 0.23^{deB}
Code (7)	2.99 ± 0.02^{aA}	4.19 ± 0.12^{eB}	3.98 ± 0.14^{fC}
Code (8)	2.98 ± 0.01^{abA}	3.50 ± 0.17^{gfB}	3.50 ± 0.10^{gC}
Code (9)	2.99 ± 0.02^{aA}	3.27 ± 0.15^{gB}	3.37 ± 0.06^{gC}

Different small letters have a significant difference in the column and different Capital letters have a significant difference in the row ($p < 0.05$).
Code (1): Control sample (Cookie without SSMF and MFWE), Code (2): Cookie containing 15% SSMF and 0% MFWE, Code (3): Cookie containing 20% SSMFand 0% MFWE, Code (4): Cookies containing 0% SSMF and 1% MFWE, Code (5): Cookies containing 0% SSMF and 2% MFWE, Code (6): Cookie containing 15% SSMF and 1% MFWE, Code (7): Cookie containing 20% SSMF and 1% MFWE, Code (8): Cookies containing 15% SSMF and 2% MFWE, Code (9): Cookies containing 20% SSMF and 2% MFWE.

Table 8. Color characteristics of cookie samples containing different amounts of SSMF and MFWE on the day of cooking.

Treatments	L*	a*	b*
Code (1)	67.72±0.14[a]	3.24±0.28[f]	39.38±0.07[g]
Code (2)	62.00±0.04[f]	1.23±0.01[g]	43.46±0.12[d]
Code (3)	59.54±0.08[g]	1.11±0.10[g]	43.87±0.10[d]
Code (4)	66.87±0.09[a]	6.98±0.01[b]	41.65±0.14[f]
Code (5)	64.77±0.06[bc]	7.83±0.02[a]	42.66±0.07[e]
Code (6)	65.66±0.18[b]	4.38±0.02[e]	44.52±0.07[c]
Code (7)	64.34±0.17[cd]	5.63±0.04[e]	45.68±0.12[b]
Code (8)	63.51±0.13[de]	4.02±0.12[c]	44.91±0.12[c]
Code (9)	62.89±0.85[ef]	4.95±0.07[e]	46.89±0.07[a]

Different small letters have a significant difference in the column ($p < 0.05$).
Code (1): Control sample (Cookie without SSMF and MFWE), Code (2): Cookie containing 15% SSMF and 0% MFWE, Code (3): Cookie containing 20% SSMFand 0% MFWE, Code (4): Cookies containing 0% SSMF and 1% MFWE, Code (5): Cookies containing 0% SSMF and 2% MFWE, Code (6): Cookie containing 15% SSMF and 1% MFWE, Code (7): Cookie containing 20% SSMF and 1% MFWE, Code (8): Cookies containing 15% SSMF and 2% MFWE, Code (9): Cookies containing 20% SSMF and 2% MFWE.

3.2.4. pH

The results of the present study showed that the addition of SSMF resulted in a significant decrease in the pH of the samples compared to the control sample ($p \leq 0.05$). The reason for this can be attributed to the pH of SSMF (6.80) and used flour (6.90). But adding the MFWE did not result in a significant difference in the amount of pH of the samples ($p > 0.05$). The lowest pH in samples 3 (cookies containing 20% SSMF and 0% MFWE), 7 (cookies containing 20% SSMF and 1% MFWE), 8 (Cookies containing 15% SSMF and 2% MFWE) and 9 (cookies containing 20% SSMF and 2% MFWE) were observed and the highest pH belonged to the control sample and samples. 4 (cookie contained 20% of SSMF and 2% of MFWE) and 5 (cookie contained 0% of SSMF and 2% of MFWE) ($p \leq 0.05$). Alimi et al. (2014) in investigating the effect of adding evening primrose meal in sponge cake formulation stated that increasing the amount of meal, increased the moisture and water activity of the samples.

3.2.5. Moisture

The results of moisture content of cookie samples (Table 5) showed that in all three time periods, the addition of SSMF and MFWE increased the moisture content of the samples compared to the control sample ($p \leq 0.05$). The lowest moisture content was observed in the control sample and the highest in sample 9 (cookie containing 20% SSMF and 2% MFWE) was observed ($p \leq 0.05$). Also, over time, the moisture content of all samples decreased significantly ($p \leq 0.05$). In relation to the samples containing SSMF, it can be stated that the fibers and hydrophilic compounds have increased the moisture content of the mentioned samples. According to the researchers, there are free hydroxyl groups in fiber types that have the ability to bind to hydrogen in water. On the other hand, both soluble and insoluble fibers have the ability to retain water, with soluble fibers bonded and insoluble fibers in a network (such as a sponge) (Gallaher & schneeman, 200; Skendi et al., 2009). On the other hand, most fibers have a behavior similar to hydrocolloids and this has increased the water absorption of the product (Movahed, 2017). Therefore, the amount of moisture in all treatments containing SSMF was higher than the control sample and this feature causes the treatments containing fiber to lose their water at a slower rate during storage (Movahhed & Khalatbari, 2014). Sufian et al. (2014) in the study of the effect of sweet almond meal (at levels of zero, 5 and 10%) and xanthan gum (0, 0.3, 0.6, and 1%) in the production of gluten-free cake stated that Almond meal increased the moisture content of the samples. Tavan et al. (2017) in investigating the effect of sesame meal (12.5%) and soy soluble polysaccharide in water (0-2%) on some physicochemical and sensory properties of barbary bread stated that adding sesame meal, the moisture content of bread was increased significantly.

3.2.6. Antioxidant activity

The results of antioxidant activity (IC_{50}) of cookie samples (Table 6) showed that in all three time periods, the addition of SSMF and MFWE resulted in a significant increase in antioxidant activity (decrease in IC_{50}) compared to the control sample ($p \leq 0.05$). Combined samples showed higher antioxidant activity (lower IC_{50}) so that the highest amount of antioxidant activity in Treatment 8 (cookie containing 15% SSMF and 2% MFWE) and Treatment 9 (cookie Containing 20% of SSMF and 2% of MFWE) which contained the highest amounts of sunflower meal flour and MFWE were observed ($p \leq 0.05$). The highest IC_{50} (lowest antioxidant activity) belonged to the control sample (cookie without SSMF and MFWE) ($p \leq 0.05$). Also, over time, the antioxidant activity of all samples decreased significantly and their IC_{50} level increased significantly ($p \leq 0.05$). Considering significant amounts of phenolic compounds in MFWE and SSMF, increasing the antioxidant activity of cookie samples, the results were not unexpected. The results of the present study were in line with the findings of Grassok et al. (2019) in the study of the effect of adding fat sunflower seed flour at the levels of 18 and 36% by weight on the biscuit, which acknowledged the amount of phenol by adding sunflower seed flour. The total and antioxidant properties of the samples increased significantly (Grassok et al., 2019). Baydar and Baydar (2013) reported that the highest values of total phenolic compounds from hot and cold methanolic extracts of rose leaves were 478.34 and 530.40 mg/g, respectively, and leaf extracts at a concentration of 50 µg/ml had anti-inflammatory activity showing more radicality even better than synthetic antioxidants such as Trolox, BHA and BHT. Schieber et al. (2005) stated that kaempferol glycosides, together with kaempferrol aglycone, which make up 80% of the total compounds, were obtained numerically with kaempferol O-3-glucoside being the predominant component. The high flavonol content, approximately 16 g/kg dry weight,

indicated that distilled rose petals were a promising source of phenolic compounds that could be used as natural antioxidants. Izzreen (2011) in the study of the effect of using plant extracts (curry leaves, Cambodian mint leaves, Brong leaf leaves) in cakes and comparing their antioxidant activity stated that samples containing the tangerine leaves extract have the highest antioxidant activity compared to samples containing curry and cambodian leaf extracts. Therefore, the addition of tangerine leaf extract as a natural antioxidant was suggested to increase the shelf life of cakes. Investigating the antioxidant effect of Shirazi chamomile essential oil and spring orange essential oil on the shelf life of the cake, they stated that the sample containing chamomile essential oil and orange spring essential oil at a concentration of 0.15% compared to the sample without antioxidants had significant antioxidant properties. They had higher oxidants. But the activity of these two essential oils was weaker than the synthetic antioxidant activity (TBHQ) used as antioxidants.

3.2.7. Peroxide value

The results of peroxide value of cookie samples (Table 7) showed that on day 0, there was no statistically significant difference in the peroxide value of treatments ($p > 0.05$). At intervals of 10 and 20 days after production, the addition of SSMF and MFWE, led to a significant reduction in peroxide value compared to the control sample ($p \leq 0.05$). Increasing the amount of SSMF and MFWE led to a significant decrease in the peroxide value of the samples ($p \leq 0.05$). So that the highest amount of peroxide value in the control sample and the lowest amount in samples 9 (cookie containing 20% SSMF and 2% MFWE) and 8 (cookie containing 15% SSMF and 2% MFWE, which contained the highest amounts of SSMF and MFWE, was observed ($p \leq 0.05$). Also, over time, the peroxide value of all samples increased significantly ($p \leq 0.05$). The peroxide value represents the primary products (hydroperoxides) of lipid oxidation (especially unsaturated fatty acids) and is used to measure oxidation progression (Taheri et al., 2012). Some researchers believe that the antioxidant activity of the plant extract is due to their reducing properties, which play an important role in the absorption and neutralization of free radicals, inactivation of single and triple oxygen and decomposition of peroxides (Migue et al., 2010). In the present study, the reason for the lower peroxide number of samples containing higher amounts of MFWE was due to the presence of phenolic compounds and its high antioxidant activity. Izzreen (2011) to investigate the effect of using plant extracts (curry leaf, Cambodian mint leaf, Tonga leaf) in cake and comparing their antioxidant activity with samples containing ascorbic acid and BHA/BHT in delaying the deterioration of oxide samples For 15 days at room temperature showed that with increasing the concentration of extracts, the amount of peroxide value and thiobarbiotic acid index of cake samples decreased significantly.

3.2.8. Colorimetric analysis

3.2.8.1. Lightness (L* value)

The results of L* value of cookie samples (Table 8) showed that the addition of SSMF resulted in a significant reduction of L* value compared to the control sample ($p \leq 0.05$) and also the addition of 2% MFWE was a statistically significant difference in the L* value compared to the control sample ($p \leq 0.05$). Increasing the amount of SSMF and MFWE led to a significant decrease in the L* value of samples ($p \leq 0.05$). So that the highest amount of L* value was observed in the control sample and the lowest amount was observed in sample 3 (cookie containing 20% SSMF and 0% MFWE) ($p \leq 0.05$). The color value L* value the amount of darkness and light (light-dark, 0-100) (Pino & Gonzalez, 2002). Due to the fact that the color of SSMF was smoky cream, its higher values led to a darker sample.

3.2.8.2. Redness (a*value)

The results of a* value of cookie samples (Table 8) showed that the addition of SSMF led to a significant reduction in a* value and the addition of MFWE resulted in a significant increase in a* value compared to the control sample ($p \leq 0.05$). Increasing the amounts of SSMF did not result in a significant difference in a* value of the samples ($p > 0.05$) and on the other hand, with increasing the amounts of MFWE, a* value of the samples increased significantly ($p \leq 0.05$).

So that the highest a* value in sample 5 (cookie containing 0% SSMF and 2% MFWE) and the lowest a* value in sample 2 (cookie containing 15% SSMF and 0% MFWE) and 3 (cookie containing 20% SSMF and 0% MFWE) were observed ($p \leq 0.05$). The color value a * indicates redness in the samples (absolute red-absolute green, -120 - +120). A positive score indicates redness of the sample, while a negative score indicates that the sample is green (Majzoobi et al., 2013). Due to the color of MFWE (reddish brown) and SSMF (Smoky cream), higher amounts of MFWE have increased and SSMF has reduced the color a* value (redness).

3.2.8.3. Yellowness (b* value)

The results of b* value of cookie samples (Table 8) showed that the addition of SSMF and MFWE resulted in a significant increase in b* value compared to the control sample ($p \leq 0.05$). Increasing the amount of SSMF showed a statistically significant difference in the b* value on the other hand, with increasing the amounts of MFWE, the b* value samples increased significantly ($p \leq 0.05$). So that the highest amount of in b* value sample 9 (cookie containing 20% SSMF and 2% MFWE) and the lowest amount in the control sample (cookie without SSMF and MFWE) was observed ($p \leq 0.05$). Positive values of b* value indicate the amount of yellowness of the sample and negative values indicate the degree of tendency to blue of the sample (absolute yellow- absolute blue, -120 + -120) (Majzoobi et al., 2013). Due to the color of MFWE (reddish brown) and SSMF (Smoky cream), higher amounts of MFWE and SSMF have increased b* value .The results of the present study were in line with the findings of Grassok et al. (2019) in investigating the effect of adding sunflower meal flour with fat levels of 18 and 36% by weight in biscuits, which showed that with increasing levels of sunflower meal flour, the samples were dark They were wet and had less redness and yellowing. Jahandideh et al. (2013) in the study of wheat flour enrichment with sesame meal and modification of rheological properties of dough and physical-textural properties of bulk bread (baguette) with xanthan gum, stated that with increasing concentration of sesame meal from 4.37 to 45.9%, L*value of shell color decreased significantly and a* value and b* value shell color increased.

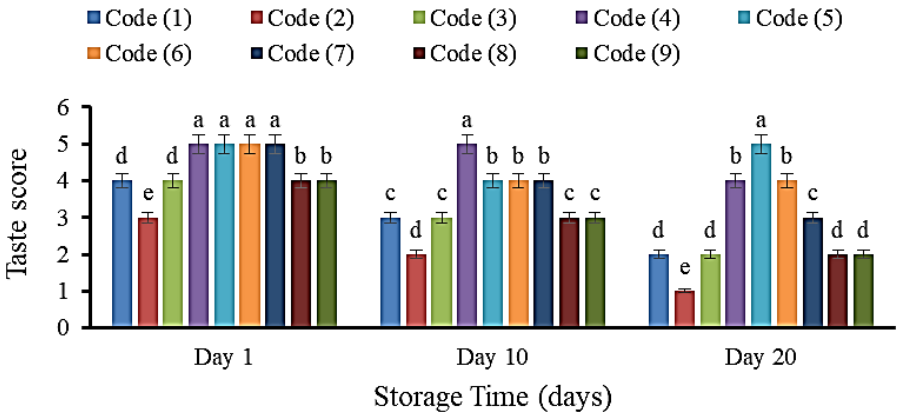

Fig. 1. Taste score of cookie samples containing different amounts of SSMF and MFWE during storage.
Different small letters have a significant difference ($p < 0.05$).
Code (1): Control sample (Cookie without SSMF and MFWE), Code (2): Cookie containing 15% SSMF and 0% MFWE, Code (3): Cookie containing 20% SSMFand 0% MFWE, Code (4): Cookies containing 0% SSMF and 1% MFWE, Code (5): Cookies containing 0% SSMF and 2% MFWE, Code (6): Cookie containing 15% SSMF and 1% MFWE, Code (7): Cookie containing 20% SSMF and 1% MFWE, Code (8): Cookies containing 15% SSMF and 2% MFWE, Code (9): Cookies containing 20% SSMF and 2% MFWE.

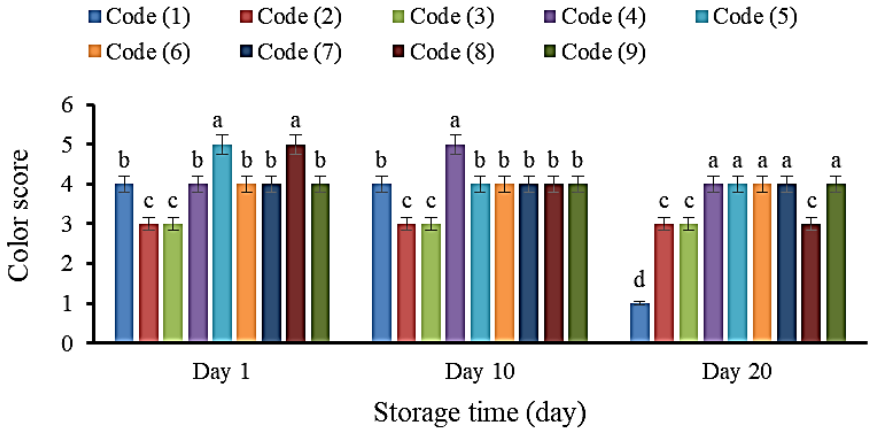

Fig. 2. Color score of cookie samples containing different amounts of SSMF and MFWE during storage.
Different small letters have a significant difference ($p < 0.05$).
Code (1): Control sample (Cookie without SSMF and MFWE), Code (2): Cookie containing 15% SSMF and 0% MFWE, Code (3): Cookie containing 20% SSMFand 0% MFWE, Code (4): Cookies containing 0% SSMF and 1% MFWE, Code (5): Cookies containing 0% SSMF and 2% MFWE, Code (6): Cookie containing 15% SSMF and 1% MFWE, Code (7): Cookie containing 20% SSMF and 1% MFWE, Code (8): Cookies containing 15% SSMF and 2% MFWE, Code (9): Cookies containing 20% SSMF and 2% MFWE.

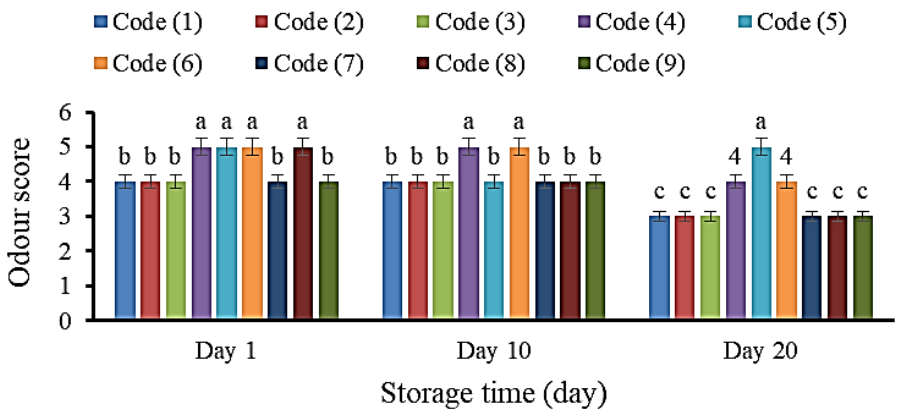

Fig. 3. Odour score of cookie samples containing different amounts of SSMF and MFWE during storage.
Different small letters have a significant difference ($p < 0.05$).
Code (1): Control sample (Cookie without SSMF and MFWE), Code (2): Cookie containing 15% SSMF and 0% MFWE, Code (3): Cookie containing 20% SSMFand 0% MFWE, Code (4): Cookies containing 0% SSMF and 1% MFWE, Code (5): Cookies containing 0% SSMF and 2% MFWE, Code (6): Cookie containing 15% SSMF and 1% MFWE, Code (7): Cookie containing 20% SSMF and 1% MFWE, Code (8): Cookies containing 15% SSMF and 2% MFWE, Code (9): Cookies containing 20% SSMF and 2% MFWE.

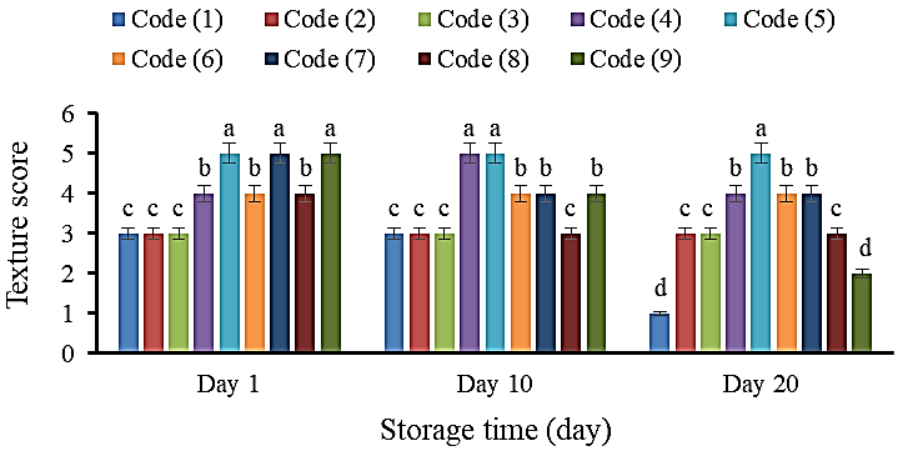

Fig. 4. Texture score of cookie samples containing different amounts of SSMF and MFWE during storage.
Different small letters have a significant difference ($p < 0.05$).
Code (1): Control sample (Cookie without SSMF and MFWE), Code (2): Cookie containing 15% SSMF and 0% MFWE, Code (3): Cookie containing 20% SSMFand 0% MFWE, Code (4): Cookies containing 0% SSMF and 1% MFWE, Code (5): Cookies containing 0% SSMF and 2% MFWE, Code (6): Cookie containing 15% SSMF and 1% MFWE, Code (7): Cookie containing 20% SSMF and 1% MFWE, Code (8): Cookies containing 15% SSMF and 2% MFWE, Code (9): Cookies containing 20% SSMF and 2% MFWE.

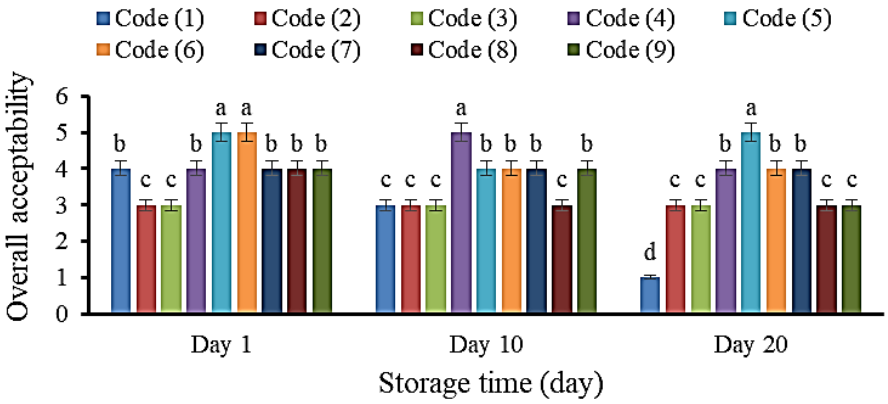

Fig. 5. Overall score of cookie samples containing different amounts of SSMF and MFWE during storage.
Different small letters have a significant difference ($p < 0.05$).
Code (1): Control sample (Cookie without SSMF and MFWE), Code (2): Cookie containing 15% SSMF and 0% MFWE, Code (3): Cookie containing 20% SSMFand 0% MFWE, Code (4): Cookies containing 0% SSMF and 1% MFWE, Code (5): Cookies containing 0% SSMF and 2% MFWE, Code (6): Cookie containing 15% SSMF and 1% MFWE, Code (7): Cookie containing 20% SSMF and 1% MFWE, Code (8): Cookies containing 15% SSMF and 2% MFWE, Code (9): Cookies containing 20% SSMF and 2% MFWE.

3.2.9. Evaluation of sensory test results

3.2.9.1. Taste

The results of taste score of cookie samples (Fig. 1) showed that in all three time periods, the addition of MFWE resulted in a significant increase in taste score compared to the control sample ($p \leq 0.05$), which can be attributed to the variety of flavor-producing compounds remaining in MFWE. Addition of 15% SSMF did not cause a statistically significant difference in taste score compared to the control sample ($p > 0.05$), but addition of 20% SSMF reduced the cookie flavor score compared to the control sample ($p \leq 0.05$). Also, over time, the taste score of all treatments except treatment 4 (cookie containing 0% SSMF and 1% MFWE) was decreased significantly ($p \leq 0.05$).

3.2.9.2. Color

The results of color score of cookie samples (Fig. 2) showed that in all three time periods, the addition of SSMF led to a significant decrease in color score compared to the control sample ($p \leq 0.05$). With increasing the amounts of MFWE, the color score of the samples increased significantly ($p \leq 0.05$). The sample containing 1% of MFWE did not cause a statistically significant difference ($p > 0.05$) in taste score compared to the control sample, but the addition of 2% MFWE resulted in a significant increase in color score ($p \leq 0.05$). According to the results of the instrumental colorimetric test, it seems that with increasing the amount of SSMF, the samples became darker and their yellowness increased, which led to a decrease in their color score by panelist. Thus, in all time periods, it showed that the lowest color score belonged to treatments 2 (cookies containing 15% SSMF and 0% MFWE) and 3 (cookies containing 20% SSMF and 0% MFWE), and also over time, the color score of all samples decreased significantly ($p \leq 0.05$). The results of the present study were in line with the findings of Grassok et al. (2019) in the study of the effect of adding sunflower seed flour with fat levels of 18 and 36% by weight in biscuits, which acknowledged that samples produced with sunflower meal flour, they were browner than the control sample.

3.2.9.3. Odour

The results of odour score of cookie samples (Fig. 3) showed that in all three time periods, the addition of MFWE led to a significant increase in the odor score of the samples compared to the control sample ($p \leq 0.05$) and the addition of SSMF, a statistically significant difference, did not produce odor in comparison with the control sample ($p \leq 0.05$). On day 0, the highest odor score in treatments 4 (cookie containing 0% SSMF and 1% MFWE), 5 (cookie containing 0% SSMF and 2% MFWE), 6 (Cookies containing 15% SSMF and 1% MFWE) and 8 (cookies containing 15% SSMF and 2% MFWE) were observed ($p \leq 0.05$). On the tenth day, the highest odor score belonged to treatments 4 (cookies containing 0% SSMF and 1% MFWE) and 6 (cookies containing 15% SSMF and 1% MFWE) ($p \leq 0.05$). On the twentieth day, the highest odor score was observed in sample 5 (cookie containing 0% SSMF and 2% MFWE) Also, with the passage of time, except in treatment 5 (cookie containing 0% SSMF and 2% MFWE), the odor score of all treatments decreased significantly ($p \leq 0.05$).

3.2.9.4. Texture

The results of texture score of cookie samples (Fig. 4) in all three time periods, the addition of MFWE led to a significant increase in the texture score of the samples compared to the control

sample ($p \leq 0.05$) and the addition of SSMF showed a statistically significant difference. It did not produce a control score compared to the sample ($p \leq 0.05$). In all time periods, the lowest tissue score belonged to the control sample and treatments 2 (cookie containing 15% SSMF and 0% MFWE) and 3 (cookie containing 20% SSMF and 0% MFWE). Also, over time, except in treatment 5 (cookie containing 0% SSMF and 2% MFWE), the texture score of all treatments decreased significantly ($p \leq 0.05$).

3.2.9.5. Overall acceptability

The results of overall acceptability of cookie samples (Fig. 5) in all three time periods, the addition of MFWE led to a significant increase in the overall acceptability of the samples compared to the control sample ($p \leq 0.05$) and the addition of SSMF, a statistically significant difference. Did not create a total overall acceptability compared to the control sample ($p \leq 0.05$). In all the studied days, the lowest overall acceptability was in treatments 2 (cookies containing 15% SSMF and 0% MFWE) and 3 (cookies containing 20% SSMF and 0% MFWE) and then observed in the control sample ($p > 0.05$). Also, over time, except in treatment 5 (cookie containing 0% SSMF and 2% MFWE), the overall acceptability of all samples decreased significantly ($p \leq 0.05$). The results of the present study were in line with the findings of Puraikalan (2014) who in investigating the effect of adding sunflower meal flour at 10, 20 and 30% levels to cookie samples, examined the sensory properties and acknowledged that the samples content of 10 and 20% of sunflower meal had the highest sensory score. Man et al. (2017) in the study of the effect of adding sunflower seed flour at levels of 15, 25 and 35% on the characteristics of cracker biscuits stated that with increasing the amount of sunflower flour, the overall acceptance score of the samples increased significantly and the reason for this It was attributed to the fat content of sunflower seed flour, which led to a significant improvement in the texture and flavor of the samples.

4. Conclusion

The results of the present study showed that the addition of SSMF led to a significant increase in ash, protein, fat, total fiber of the samples and a significant decrease in the pH of the samples ($p \leq 0.05$). On the other hand, the addition of SSMF and MFWE increased the moisture content, antioxidant activity and decreased the peroxide value of the extracted oil of the samples ($p \leq 0.05$). The results showed that SSMF with the aim of improving the chemical properties can be used up to 15% with the MFWE without having a negative effect on the sensory properties of the cookie.

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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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