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ORIGINAL ARTICLE

Effect of Fat Replacement by Grape Seed Oil and Rice Bran Fiber on Physicochemical and Sensory Properties of Burgers

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KEYWORDS

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Rice bran fiber;
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ABSTRACT: This study aimed to investigate the physicochemical and sensory properties of burger samples (BGSOs) formulated by various ratios of grape seed oil (GSO) and fixed rice bran fiber (RBF) as a fat replacer. The connective tissues and fat of the meat were removed as far as possible, then 15 g of these fats were added to the control sample and 5 g to each of the other burgers along with 2% RBF to obtain 4 samples as follows: control (15% fat); BGSO 5% (5% fat and 5% GSO-2% RBF); BGSO 8% (5% fat and 8% GSO-2% RBF); BGSO 10% (5% fat and 10% GSO-2% RBF). The results indicated that fat substitutes had a significant effect on the desirable properties of the final product. The results of rheological tests showed that with increasing the GSO, the shear force increased. According to proximate analysis, protein, moisture, ash, and pH, also increased. With the increase of the GSO, the calories of the samples decreased by 15 to 18%. Using rice bran fiber and grape seed oil improved the cooking efficiency of the BGSOs compared to the control burger. Also, fat retention (FR) was increased in the samples but there was no change in moisture retention (MR). According to sensory panelists, the BGSOs were generally accepted and the highest acceptability was for BGSO 10%. Based on the results, the fat replacement of the different concentrations of GSO and fixed RBF can present good physicochemical and sensory characteristics in the burger.

INTRODUCTION

Red meat is a good source of animal protein, minerals, vitamins, especially B group and iron. However, it has high levels of saturated fatty acids (SFA), cholesterol, sodium and calories that have led to cardiovascular disease, obesity, hypertension and some cancers. Reducing and replacing of meat fats with vegetable oils in meat products is one of the successful strategies to lessen SAF and improve its nutritional index [1, 2].

Fat replacers can be categorized into two groups including fat substitutes and fat mimetics. Fat substitutes are fatty acid-based substances that synthesis by some processing operation like esterification. They exhibit physical (texture) and functional (mouthfeel) properties similar to conventional fat molecules e.g., triglycerides. The most famous ingredient in fat substitutes is a polyester called Olestra (fat used in snack foods), which is made from a

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mixture of six to eight esters of SAFs and unsaturated fatty acids (UFAs). Fat substitutes are suitable for cooking and frying at high temperatures. Although they may not have the flavor of their mother's fatty acids, they can be carriers of other fat-soluble flavoring compounds. They can be replaced on a weight-for-weight basis with conventional food fats in order to reduce calories (from 0 to kcal g^{-1} content in SAFs). Fat mimetics are divided into two protein-based (which provide 4 kcal g^{-1}), such as Simplesse (which is produced by microparticulation of whey protein concentrate) or carbohydrate-based like gums and fibers which provide energy ranging from zero for non-digestible to 4 kcal g^{-1} for digestible carbohydrates. Fat mimetics able mimic the organoleptic and physical properties of conventional fat molecules. These compounds are not suitable for cooking and frying applications at high temperatures and cannot be substituted on a weight-for-weight basis with conventional fat [3]. Fat replacers are macromolecules that are used to provide all or part of the fat function in a food products [4].

Recently, in order to increase the level of public health and reduce problems caused by animal origin fats, replacing part of the animal fats with vegetable oils and fiber in meat products has become a significant topic among researchers around the world [5]. So far, various vegetable oils, fibers and other fat replacers have been used to partially replace instead of the fat in these products, for example, using of canola, olive, and sunflower oils to replace pork back fat in chicken sausages [6], microparticles of chia oil enriched with rosemary in beef burgers [7], hydrated wheat fiber replacing meat and fat in beef burgers [8], canola and olive oils and prebiotic fibers (a blend of 2.2% β-glucan and 3.1% inulin) in low-fat beef burgers [9], canola and flaxseed oils in sausages from spent layer meat [10], canola oil and pineapple byproduct in low-fat beef burger [11], sesame oil and sugarcane dietary fiber in low-fat meat batter [12], gelled carrageenan emulsion containing sunflower oil in beef-pork burgers [13] and Wakame/olive oil added in low-salt, low-fat beef patties [14].

Grape seed oil (GSO) has a very mild flavor and mainly consists of triglycerides. About 90-80% of total fatty acids are UFAs. This oil contains 14-15% oleic acid (18:1), 58-78% linoleic acid (18:2) (which is higher than those in other oils, such as soy beans and corn, with values ranging from 48 to 59% and 34 to 65.6%, respectively), 0- 0.6% alpha-linolenic acid (18:3), and about 10-18% saturated fatty acids including palmitic acid (16:0) and stearic acid (18:0) [15, 16].

Rice bran (RB) is one of the valuable by-products of conversion of rice to white rice, which produces large amounts of food waste annually, has many bioactive substances that are capable of reducing the risk of non-communicable chronic diseases [17]. On a dry basis, RB contains 25% protein which is highly digestible and can even be used in baby food due to its allergy-reducing properties [18]. The RB is rich in rice bran fiber (RBF) including insoluble dietary fiber and slightly soluble dietary fiber which has the latter benefits of improving the physicochemical and sensory properties of foods [19]. Since this compound contains a significant amount of dietary fiber and considering that dietary fiber has important functional, functional and nutritional properties, therefore extracting fiber from these compounds and applying it in a variety of products have a lot of research.

The aim of the present study was to evaluate the possibility of fat reduction and its replacement by a combination of different level grape seed oil (GSO) and fixed level of rice bran fiber (RBF) in burger formulation and to investigate the physical, chemical and sensory properties of the produced samples.

MATERIALS AND METHODS

Materials

Rice bran (RB) (Noora brand, Iran) (12.12% moisture, 12.32% protein, 20.31% fat, 8.73% ash, 28.60% fiber, pH 6.85) was obtained from a local store. Grape seed oil (GSO) (Zareen Talia brand, Iran) was obtained from a local store and prepared the same day before use. Soy protein isolate (SPI) was obtained from Behtom Powder, Iran. Calf meat was purchased from local market. All analytical grade of chemicals used in the study were purchased from Sigma-Aldrich, Germany.

Rice bran fiber preparation

Until now, various methods have been employed to extract fiber from plant sources, including wet process, dry process, chemical, physical, enzymatic, microbial and gravimetric, or a combination of these methods [20-24]. In this study, rice bran fiber (RBF) was extracted by enzymatic gravimetric method according to the modified AOAC method [25]. The bran was first milled and passed through a sieve with mesh 25. Then it was roasted in an oven (JEIO TECH, South Korea) at 100°C for 10 minutes to inactivation of buds subsequent activity that cause bitterness in the final product. Rice bran fiber (11.73% moisture, 21.91% protein, 4.31% fat, 7.42% ash, 53.25% fiber, pH 7.07) was packed and kept at 4°C until use.

Preparation of emulsified grape seed oil

Emulsified grape seed oil was prepared with mixing of eight units of hot water and one unit of SPI for 2 minutes. It was then added with 10 units of GSO and mixed for a further 3 minutes to give a stable emulsion of water-GSO-SPI [9, 26]. The emulsified GSO was stored at 5°C until use in the bottle glass.

Formulations of burgers

Visible fats and connective tissue of calf meat were completely separated, then the meat was minced by a meat mincer in 3.5 mm above 0 °C to obtain a homogeneous mixture. The formulation components of the treatments are listed in Table 1. After mixing, the resulting mixture were molded in diameter of 10 cm and a thickness of 1 cm and stored at -18 °C in a freezer.

Table1 The ingredients of burgers formulation (%)

Ingredients	Treatments (%)			
	Control	**BGSO 5%**	**BGSO 8%**	**BGSO 10%**
Veal	48	48	48	48
Fat	15	5	5	5
GSO [a]	-	5	8	10
RBF [b]	-	2	2	2
SPI [c]	-	0.6	0.6	0.6
Rusk flour	8	8	8	8
Onion	27.35	25	23	21
Cinnamon	0.05	0.05	0.05	0.05
Salt	1.2	1.2	1.2	1.2
Pepper	0.2	0.2	0.2	0.2
Nut	0.2	0.2	0.2	0.2
Water	-	4.75	3.75	3.75

[a] GSO, grape seed oil, [b] RBF, Rice bran fiber, [c] SPI, Soy protein isolate.

Cooking of burger samples

The frozen burger samples were removed from the freezer 12 hours before the test and transferred to the refrigerator at 5 °C for thawing. The cooking procedure was conducted in an convection oven (Oster, TSSTTVF816, Countertop, China) with an inlet temperature of 135 °C and an output temperature of 190 °C for 8 minutes to reach the geometrical center temperature of the samples to 71°C [27].

Proximate analysis and energy content (kcal)

After cooking of samples, various chemical measurements were carried out according to AOAC [25] including determination of pH, moisture content, ash content, fat content and total protein content which the latest was obtained by measuring the total nitrogen and converting the obtained protein to the protein value by multiplying it by a coefficient of 6.25.

The calorie content of the samples was calculated based on the Atwater factor method which calculates the total calorie value of the burger by calculating of all the ingredients in the burger [28].

Determination of cooking properties

Cooking characteristics including cooking yield, moisture retention and fat retention were measured by the methods which described by Afshari, Hosseini [9] as the following equations:

$$Cooking\ yield(\eta) = \frac{M_{cooked\ sample}}{M_{raw\ sample}} \times 100 \quad (1)$$

$$Moisture\ retention\ = Cooking\ yield(\eta)\ \times \frac{M_{\ moisture\ in\ cooked\ burger}}{M_{\ moisture\ in\ raw\ burger}} \times 100 \quad (2)$$

$$Fat\ retention\ = Cooking\ yield(\eta)\ \times \frac{M_{\ fat\ in\ cooked\ burger}}{M_{\ fat\ in\ raw\ burger}} \times 100 \quad (3)$$

All determinations were performed three times.

Texture analysis

The Warner Bratzler shear force (WB) measurements were performed in three replications on cooked burgers as following this procedure: samples were cooled after baking to ambient temperature (25 °C) and a slice of 1 cm in thickness separated from the center of each sample. Texture analysis were done using the texture analyzer (M 350-10 CT, Testometric Co. Ltd., Rochdale, Lancs, UK) using a 3 mm Warner-Bratzler shear blade for three times with a speed rate of 20 cm/min. The data were computed and the mean obtained were expressed in Newton [9, 29].

Color measurement

The surface color of each raw and cooked burger was measured by a colorimeter (Minolta, Chroma meter CR-210, Minolta Co., Japan) as following the method described by Selani, Shirado [11]. Thus, the average of the five points of each burger were considered to determine of these color parameters: brightness (L^*), redness (a^*) and yellowness (b^*).

Sensory evaluation

Cooked burgers sensory properties were measured [13] by ten educated panellist (Department of Food Science and Technology, Islamic Azad University of Damghan, Damghan, Iran) using a 5-point hedonic test where 1 represented the sensory parameters of taste, color, aroma, juiciness, crunchiness, appearance and overall acceptance were extremely undesirable and 5 represented those 7 parameters were extremely desirable. The burgers were heated (38 °C) to sensory testing. To clean the palate between experiments were served salt-free crackers and distilled water to panellist.

Statistical analysis

All experiments were performed with three replications. Data were analyzed by SPSS software version 24 in a completely randomized design with factorial arrangement. One-way analysis of variance (ANOVA) with Duncan's multiple range test was used to determine the significant differences ($P < 0.05$). The charts were plotted by Microsoft Excel 2013 software.

RESULTS AND DISCUSSION

Proximate analysis of cooked samples

Table 2 presents the proximate composition of the cooked burgers. The main purpose of this study was to produce a low-fat burger so that its quality is maintained because it can attract positive feedback from consumers. As expected, the highest amount of fat was related to control burgers and the lowest fat content was observed in the BGSO 10% sample (burger containing 2% RBF and 10% GSO), while the highest calorie content was observed in control sample and the lowest calorie content was observed in the BGSO 5% sample. According to the fat content results, there is a significant difference between the samples and the results can confirm the purpose of producing low-fat burgers. Afshari, Hosseini [30] reported a 37% reduction when the use of olive and canola oil instead of animal fat in burgers. Abedini, Varidi [27] in their study were applied the melon seed fiber instead of animal fat in sausage and burger samples. They observed a decrease in fat content. All of observations are consistent with our findings.

Although adding a mixture of RBF and GSO to the typical burger formulation somewhat increased the moisture content of the cooked burgers, but it did not significantly difference between low-fat burger treatments and had a significant difference with control ($P< 0.05$). These differences are primarily related to the amount of water added to the formulation of each treatment. The highest moisture content was associated to BGSO 10% and the lowest moisture content was related to the control. Similar results were reported in replacing part of the burgers' fat with fiber and vegetable emulsified oil by Zhuang, Han [12], Selani, Shirado [11] and Choi, Choi [31] using sugarcane dietary fiber (SDF) and sesame oil, pineapple byproduct and canola oil, and vegetable oils and rice bran fiber as fat replacers in burgers of pork, low-fat beef, and low-fat pork meat emulsion systems respectively, which was showed that adding fibers such as RBF to burger increased moisture contents and oil emulsion stability of meat batter. Protein contents of cooked burgers by enhancing the amount of grape seed oil were not statistically significant ($P< 0.05$). Zhuang, Han [12] explained that the amount of protein in cooked burgers depends on factors such as the binding properties of the fat and water of the emulsion system created in the structure of the burgers, and cooking reduces some of the water-soluble proteins. Ash content of burgers ranged from 1.87 to 1.93%. Replacing vegetable oil and fiber with animal fat in veal burgers although due to the addition of RBF indicates a slightly higher ash content, but does not have a statistically significant effect on the ash content burgers. The results of this experiment were consistent with the results of a study by Choi, Choi [31], Choi, Choi [32] and Moghtadaei, Soltanizadeh [33]. The results of pH were showed statistically significant difference ($P< 0.05$) between control and treatments and were consistent with the results of research by Choi, Choi [32] in which they examined the effect of fat replacement with RBF on sausage. This increase in pH was due to the alkaline properties of RB. We also observed in the results that the lowest pH related to control and the highest pH of all 3 treatments were observed in the same amount. Formulated burgers showed lower energy contents than control with 185.57 kcal/100 g. There are significant difference between all treatments with a significant interaction of $P < 0.001$. López-López, Cofrades [14] explained that the cooking method could affect the calorie content of burgers.

Table 2. Proximate composition (%), and energy content (EC) of formulated cooked burgers.

Samples	Fat (%)	Moisture (%)	Protein (%)	Ash (%)	pH	EC (Kcal)
Control	14.80 ± 0.8^a	64.15 ± 2.41^b	11.35 ± 0.58^a	1.87 ± 0.31^a	6.02 ± 0.08^b	185.57 ± 4.58^a
BGSO 5%	10.34 ± 0.52^d	65.94 ± 1.46^a	11.41 ± 0.42^a	1.91 ± 0.39^a	6.12 ± 0.05^a	151.57 ± 3.29^d
BGSO 8%	11.10 ± 0.88^c	66.04 ± 1.61^a	11.47 ± 0.66^a	1.93 ± 0.56^a	6.11 ± 0.02^a	154.41 ± 5.45^c
BGSO 10%	11.40 ± 0.29^b	66.17 ± 2.21^a	11.50 ± 0.38^a	1.92 ± 0.41^a	6.11 ± 0.03^a	157.33 ± 4.68^b

All values are mean ± standard deviation of three replicates. $^{a–d}$ Small letters indicate significant differences within a column ($p < 0.05$) obtained for the three formulated cooked burgers. Control: 15% fat, BGSO 5%: 5% fat and 5% GSO-2% RBF, BGSO 8%: 5% fat and 8% GSO-2% RBF, BGSO 10%: 5% fat and 10% GSO-2% RBF.

Cooking properties and WB shear force

Cooking-physical properties and WB shear force analysis of cooked burgers which were formulated with different level of GSO and fixed RBF are presented in Figure 1.

Although the formulated burgers had a slightly higher residual moisture content in comparison with control sample, but the values obtained from cooked hamburgers moisture retention showed that neither the rice bran fiber 2% nor grape seed oil in levels of 5, 8, and 10% (additives added as fat reducers) had no effect on moisture retention statistically ($p < 0.05$). Formulation of burgers increased the yield of cooking and fat retention in cooked burgers which the resulting difference was significant statistically ($p < 0.05$) between the formulated samples and control sample. The results showed that adding 2% rice bran fiber to the burgers caused this change because by adding different levels of grape seed oil was not observed statistical difference in fat retention and cooking yield between the formulated samples.

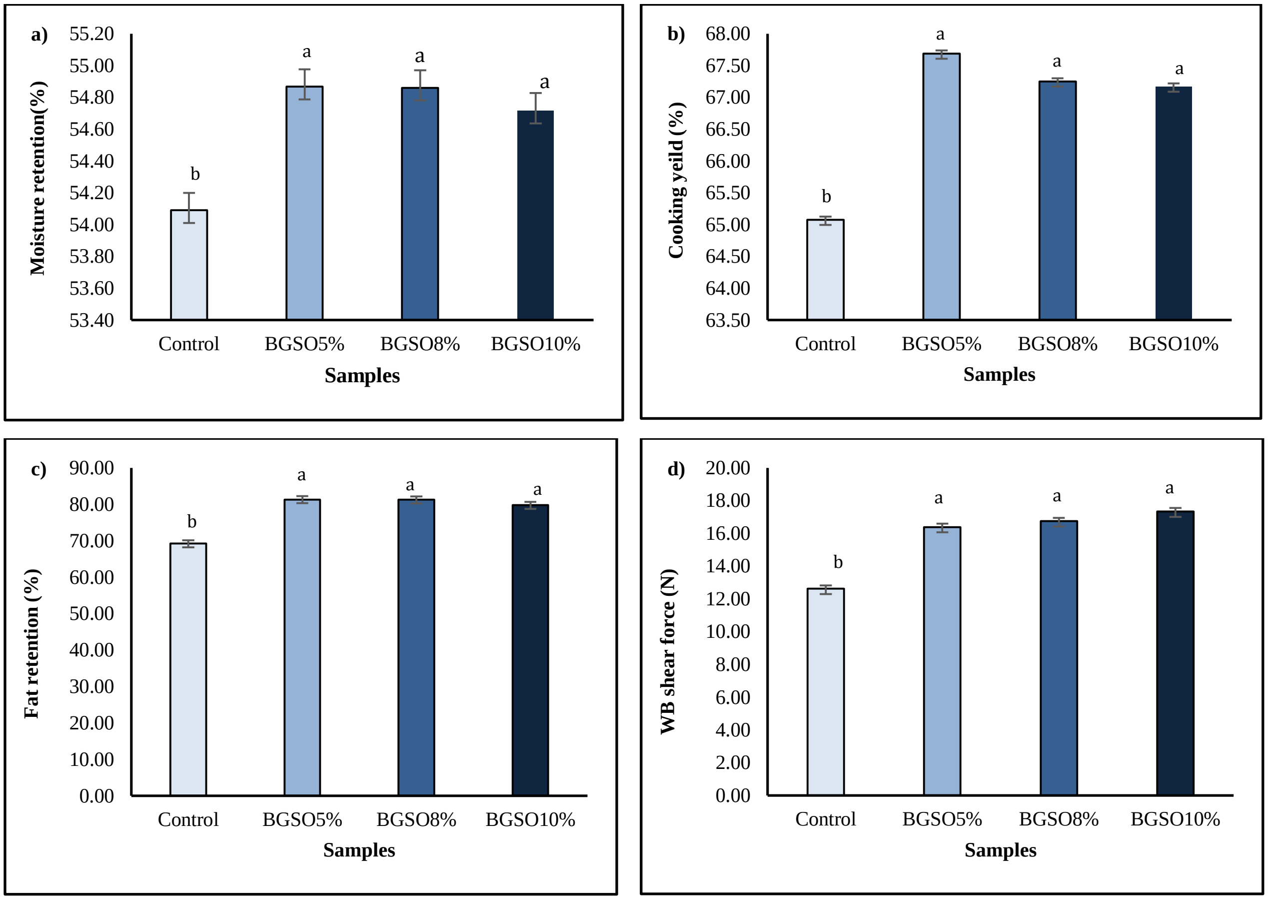

Figure 1. Cooking properties: a) moisture retention, b) cooking yield, c) fat retention, and d) Warner Bratzler shear force (N) of cooked burgers. All values are mean ± standard deviation of replicates. [a–b] Different small letters show significant differences between columns ($p < 0.05$) obtained for formulated cooked burgers including: control: 15% fat, BGSO 5%: 5% fat and 5% GSO-2% RBF, BGSO 8%: 5% fat and 8% GSO-2% RBF, BGSO 10%: 5% fat and 10% GSO-2% RBF.

In this study, as the fat level of the samples was changed from 15% of animal fat in control burger to 10, 13 and 15% of plant-animal substituted fat in BGSO 5%, BGSO 8% and BGSO 10% burgers, the moisture retention rate was only approximately 0.78, 0.77 and 0.63 increased, while fat retention, with changes in fat levels in formulated burgers, was 20.3%, 20% and 16.4%, respectively. Also, as shown in Figure 1 a, b, and c, the cooking efficiency in BGSO 5%, BGSO 8% and BGSO 10% samples were about 5.7, 4.9 and 4.6, respectively. Significant reduction in cooking efficiency in the control sample can be due to reasons such as reduced fat and moisture during cooking, both of which are affected by the fat content of the sample. In this way, the higher fat content of the sample, the smaller the distance between the fat cells and the greater the possibility of a coalition of these cells, thus losing more during the cooking process due to dripping [9]. Improvements in fat and moisture retention in BGSO5% pre-emulsified herbal fat-replaced burgers can be attributed to the stabilization effect of the vegetable / animal oil ratio in the established emulsion system [34]. Similar results are obtained from the use of vegetable oils as a substitute for fat such as, canola and flaxseed oils in sausages [10], reduced-fat beef species sausage replaced by pineapple dietary fibres and water [35], pineapple byproduct and canola oil as fat replacers in low-fat beef burger [11], and Wakame/olive oil added to beef patties [14].

The effect of the combination of rice bran fiber and different levels of grape seed oil on the amount of the samples WB are also given in Figure 1, d. Although compared to the control sample, the formulation of the burgers increased the shear force, there was no significant difference between the different levels of grape seed oil ($p < 0.05$). The sample with 10% grape seed oil had the highest shear force. The Warner-Bratzler shear force (WBSF) or WB shear force is defined as the maximum force required to shear a piece of sample and generally applied to predict meats tenderness [11]. According to WB shear force results, control and BGSO 10% displayed the lowest and the most noteworthy values, respectively. There was significant difference among control and the fat replacing treatments with grape seed oil and rice bran fiber addition. Youssef and Barbut [36] described that the fat globules created by adding canola oil in the meat emulsion formulation are smaller than those generated from animal fat. Therefore, they are covered with more surface by proteins and as a result, they create more bonding with matrix, which leads to a firmer product. Similar results were obtained when using pineapple byproduct as a fiber along with 5% canola oil in low-fat beef burgers [11] and replacing pork back fat with canola and flaxseed oils [10].

Sensory analysis

Figure 2 shows a sensory evaluation radar diagram of various burger formulations. The combination of grape seed oil and rice bran fiber among the seven measured parameters of sensory characteristics, had a more positive effect on the juiciness of the formulated products. As the amount of grape seed oil increased in the samples, the amount of juiciness also increased significantly ($p < 0.05$). Afshari, Hosseini [9] fabricated low-fat beef burgers using a mixture of 3.1% inulin and 2.2% β-glucan (prebiotic fibers) blended with canola and olive oils as beef fat substitutes which scored with the highest points of juiciness comparing other samples. They explained fibers due to improved water bonding cause to the increase in juiciness in burgers. In addition, for panelists, the best appearance and tenderness were associated to control sample, or in other words, the addition of fat-substituting compounds significantly reduced the appearance and tenderness parameters ($p < 0.05$). The results showed that the formulation of burgers did not have a significant effect on the parameters of flavor, color, aroma, and overall acceptability. Although, by adding fat replacers, the aroma of the products slightly decreased but this difference was not significant ($p > 0.05$).

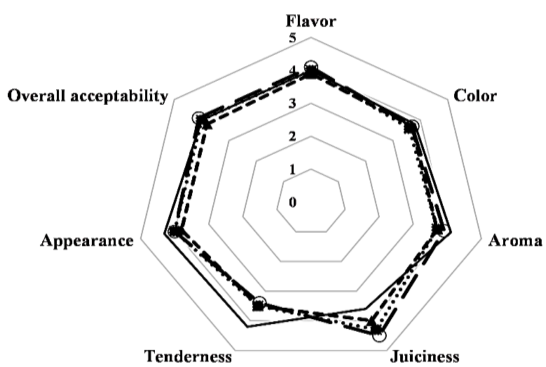

Figure 2. Radar chart of sensory evaluation of burgers made with different grape seed oil level (Control, BGSO 5%, BGSO 8%, BGSO 10%) and fixed rice bran fiber level to replace the fat. For all products a p-value of $p > 0.05$ resulted from ANOVA test among the substituted products. Scores: 1. very much less; 2. considerably less; 3. not differences; 4. considerably more; 5. very much more.

Color properties of burgers

The results obtained from the color analysis of the control and formulated samples are shown in Table 3. The lightness (L^*) parameter of the burger samples increased with the addition of rice bran fiber and grape seed oil. The highest and lowest lightness in the obtained results were related to BGSO 5% and control, respectively, and there was a significant difference between all the measured samples ($p < 0.05$). The same results obtained by Carvalho, Pires [8] who observed an increase in lightness with the partial replacement of meat and pork back fat by wheat fiber and water and Wang, Xie [37] in Harbin sausage by replacing pork fat with increasing camellia oil gels content. Henning, Tshalibe [35] stated that the high lightness was due to the presence of fiber in the samples because the rate of this parameter in the samples with fiber was higher than the samples without fiber. On the other hand, Youssef and Barbut [38] was stated the reason for this increase was due to the much smaller size of vegetable oil globules such as canola compared to large animal fat globules, which can reflect more light (larger surface area). Redness (a^* -value) of burgers showed with increasing of GSO in burgers significantly decreased, so that highest and lowest redness values related to control and BGSO 10%, respectively and yellowness (b^* -value) of samples showed a significant increase only in GSO 8% comparing other products ($p < 0.05$). Selani, Shirado [11] obtained the same results when used 1.5% pineapple byproduct in formulation of burgers comparing to control sample (without fruit fibre). Kojoori [39] and Choi, Kim [40] results showed that adding rice bran fiber reduced the color index a^* or made the samples redder and increased the color index b^* or made the sausage samples more yellow.

Table 3. Effects of RBF with various GSOs on the color (L^*-, a^*-, and b^*-values) of the formulated veal burger.

Samples	Lightness (L^* - value)	Redness (a^* -value)	Yellowness (b^* -value)
Control	77.27 ± 0.15^c	4.74 ± 0.09^a	11.96 ± 0.21^b
BGSO 5%	78.96 ± 0.11^a	4.32 ± 0.22^b	12.13 ± 0.15^b
BGSO 8%	78.19 ± 0.21^b	4.21 ± 0.14^b	12.96 ± 0.09^a
BGSO 10%	78.03 ± 0.08^b	4.01 ± 0.11^c	12.22 ± 0.08^b

The colorimeter was calibrated with a white plate with these characters: $L^* = + 97.83$, a^*=-0.43, and b^*=+ 1.98. The small letters show significant differences among samples ($p<0.05$) observed from the five measurement repetitions of formulations of cooked burgers.

CONCLUSIONS

The use of rice bran fiber and grape seed oil could have a positive effect on improving the cooking properties and the sensory characteristics of the formulated burgers by increasing yield, appearance, tenderness and juiciness. In terms of color changes, by adding rice bran fiber and grape seed oil instead of part of animal fat, the lightness of the burgers was increased and the redness of the samples was reduced, but there was no change (expect in BGSO 8%) in the yellowness of the samples. Due to the importance of color parameters in the acceptance of the product by the consumer, consuming more than 8% of grape seed oil reduces the redness of the product. According to the results of WB shear force, it has been shown that increasing the amount of grape seed oil in the burger formula shows a significant increase in shear force, which indicates that the use of these two fat substitutes together can be a good choice to minimize sensory changes. The results of this study highlight the use of rice bran fiber and grape seed emulsified oil (fiber along with the emulsion of vegetable oils) as fat substitutes to open up the possibility of a new program for this promising by-products. Further studies are recommended to evaluate the application of this combination of fiber and vegetable oil in a variety of raw and cooked meat products at different temperatures and with different cooking methods in order to optimize the acquisition of healthy meat products and increase the feasibility of use in the meat industry.

ETHICAL CONSIDERATION

This study was performed in 2014 and according to line with the principles of the Declaration of Helsinki.

Conflict of interests

None.

Authorship contribution statement

Sepideh Bamdad: formal analysis, investigation, methodology. Ali Najafi: data curation, validation, review & editing. Homa Baghaei: investigation, data curation. Hamid Babapour: Investigation, software. Ahmadreza Abedinia: software, validation, data curation, writing - review & editing.

Data availability

The data that support the findings of this study are available from the first author, upon reasonable request.

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