INTRODUCTION

Low-fat meat products play a very important role due to their health benefits and beneficial for all ages because of its nutritional and therapeutic value (Reyes-Padilla et al., 2018). In recent era, foods that are low in fats and being in the daily meal of people have captured too much attention. By balanced proteins and daily diet levels, dietary fiber and its source levels should be included in balanced diet. 

Received: 13 September 2019 Revised: 29 July 2020 Accepted: 11 August 2020 DOI: 10.1002/fsn3.1988

Utilization of wheat germ oil and wheat bran fiber as fat replacer for the development of low-fat beef patties

Anam Khalid1 | Muhammad Sohaib2 | Muhammad Tahir Nadeem1 | Farhan Saeed1 | Ali Imran1 | Muhammad Imran3 | Muhammad Inam Afzal4 | Sana Ramzan5 | Muhammad Nadeem6 | Faqir Muhammad Anjum7 | Muhammad Sajid Arshad1

1Department of Food Science, Faculty of Life Sciences, Government College University, Faisalabad, Pakistan 2Department of Food Science and Human Nutrition, University of Veterinary and Animal Sciences, Lahore, Pakistan 3Department of Diet and Nutritional Sciences, University of Lahore, Lahore, Pakistan 4Department of Food Science Technology, Government College University, Faisalabad, Layyah Campus, Pakistan 5Department of Environmental Sciences, COMSATS University Islamabad, Vehari Campus, Pakistan 6Vice Chancellor Secretariat, University of the Gambia, Banjul, The Gambia

1Department of Food Science, Faculty of Life Sciences, Government College University, Faisalabad, Pakistan 2Department of Food Science and Human Nutrition, University of Veterinary and Animal Sciences, Lahore, Pakistan 3Department of Diet and Nutritional Sciences, University of Lahore, Lahore, Pakistan 4Department of Food Science Technology, Government College University, Faisalabad, Layyah Campus, Pakistan 5Department of Environmental Sciences, COMSATS University Islamabad, Vehari Campus, Pakistan 6Vice Chancellor Secretariat, University of the Gambia, Banjul, The Gambia

Abstract

The present study was aimed to evaluate the effects of wheat germ oil and wheat bran fiber as fat replacers on quality and stability of low-fat beef patties. Total five treatments were prepared by employing wheat germ oil (WGO) and wheat bran fiber (WBF). WBF was used at fixed amount of 3% in all treatments except control in conjunction with varying WGO concentrations as follows: 1.5%, 3%, and 4.5%. Prepared raw and cooked beef patties were stored at 4°C, and further analyses were carried out up to 21 days of storage period with intermittent evaluation interval of 7 days. Higher values of TBARS, peroxide, and cholesterol were observed in raw and cooked beef patties in control, whereas minimum values were found in treatment of beef patties prepared with WGO 4.5% + WBF 3%. The physicochemical parameters were observed by pH and hunter color values. pH was higher in cooked patties as compared to beef patties and showed increases with increase in WGO concentration and storage intervals. The sensorial attributes were observed which included different parameters, such as appearance, texture, taste, odor, and overall acceptability. Higher score was given by the panelists to control for both raw and cooked beef patties; however, minimum score for all sensory properties was found in group treated with WGO 4.5% + WBF 3% within acceptable limit. In nutshell, raw and cooked beef patties treated with WGO 4.5% plus WBF 3% showed better quality, stability, and reduced cholesterol content.

Keywords

beef patties, wheat bran fiber and fat replacer, wheat germ oil
nutritional foods. Hence, due to high-fat content, beef patties are now a best choice for fat reduction. Therefore, for the maintenance of healthy lifestyle, consumers demand those meat products having good quality as well as reduced fat (Ibarra Sáiz et al., 2012).

Nowadays, low-fat meat products are used by the people who are conscious about their health. They considered these products for losing body weight because it is used as diet food. Meat continues to be the pivotal food in the whole world. By viewing the nutritional and sensory values of meat, the quality conditions are decided. The consciousness of the consumers on diet and health has expanded recently and the requirement for healthy foods, particularly meat which is a rich source of saturated fatty acids and monounsaturated fatty acids (Jalal et al., 2013).

There are different sources are used for the development of low-fat meat products. Linseed and microalgal oils have been used as a fat replacer for the development of beef patties (Alejandre et al., 2016). However, there is a need to replace the fat contents with oils and fiber having functional as well as nutraceutical importance. In this regard, wheat germ oil and wheat bran fiber used to develop functional beef patties. Wheat germ oil (WGO) is the richest plant source of vitamin E and having great potential to lower down the fat contents (Arshad et al., 2013). Wheat germ comprises about 2.5%–3.5% of the total wheat and contained 10%–15% and phytosterols present which are helpful in lowering the fat contents (Arshad et al., 2013). In addition to wheat germ oil, wheat bran fiber was also used as a fat replacer. Higher contents of fiber present in bran and whole grain (Hemdane et al., 2016). The dietary guidelines for Americans recommend to utilize half of grains as whole grains to increase the intake of fiber which is necessary for excellent health (Jacobs et al., 2015). The major source of fiber is wheat bran which is used to cure constipation and diabetes and decreasing carcinogenic material. To reduce cancer, the activity of wheat is greater as compared to fiber content or increasing particular phyto-chemical (Liu et al., 2012).

Half of the consumed food should contain whole grain. Less than 5% of Americans use the prescribed amount of whole grains which is equal to 3 ounce per day equivalent to whole grain. Frequently they consume less than 1 ounce equivalent to whole grain per day (Jonnalagadda et al., 2011). Keeping in view the above facts, the objective of the current study was to assess the impact of wheat germ oil and wheat bran fiber as fat replacers and to determine the effect of wheat germ oil and wheat bran fiber on quality and stability of raw and processed beef patties.

### 2 | MATERIALS AND METHODS

This research project was carried out at Institute of Home and Food Sciences, Government College University Faisalabad, Pakistan. Wheat germ oil and wheat bran fiber were used as fat replacer for the development of functional beef patties and then further proceeded for chemical, physical analysis, and sensory attributes. Beef meat was obtained from local grocery stores from Faisalabad. Wheat germ and wheat bran were procured from Sunny flour mills Lahore, Pakistan.

#### 2.1 | Beef patties

Wheat germ oil and wheat grain fiber were used for the development of low-fat beef patties by following the method. The meat patties were put away at 4°C for 21 days and investigation was done following seven days. At the point when all fixings were altogether blended, then a blend was exhausted in a slim layer (10 mm thickness) and shaped into round patties. In an expansive, nonstick griddle heat a large portion of the oil over medium-low warmth and for around 4 min cook a large portion of the oil over medium-low warmth and for around 4 min cook a large portion of the patties on each side or until brilliant dark colored. The preparation of beef patties with wheat bran fiber and different concentration of wheat germ oil is shown in Table 1.

#### 2.2 | Thiobarbituric acid reactive substances (TBARS) of beef patties

The TBARS value of raw and cooked beef patties was measured by following the method described by Ahn et al., 1998 with some
modifications. The TBARS value was denoted by malondialdehydes/Kg of meat.

2.3 | Peroxide value (POV) for beef patties

Peroxide value in raw and cooked beef patties was measured by method of International Dairy Federation (IDF) (Shantha & Decker, 1994). The POV was measured by using the unit mEq/Kg.

2.4 | Hunter color value of beef patties

Utilizing a Hunter colorimeter with estimations institutionalized the surface shading estimation of the examples was performed regarding a white alignment plate (L = 89.2, a = 0.921, b = 0.783). The shading CIE L (lightness), CIE a (redness), and CIE b (yellowness) values were gotten utilizing a normal incentive from 9 arbitrary readings on each sample surface for statistical analysis.

2.5 | Cholesterol contents

Total cholesterol content in raw and cooked beef patties was measured by using spectrophotometric method, as described by Rudel and Moris (1973). The cholesterol contents were measured by denoting the unit mg/100 g.

2.6 | pH measurement

The pH of raw and cooked beef patties was estimated by utilizing pH meter as indicated by the method as depicted by AOAC, 1981.

2.7 | Sensory evaluation

Sensory attributes of cooked beef patties were conducted by 10 panelists using 9-point hedonic scale. The trained panelist was given mineral water to rinse their taste receptors for rational assessment. Different attributes like appearance, texture, odor, taste, and overall acceptability were assessed by the guidelines outlines by Lawless & Heymann, 2013.

2.8 | Statistical analysis

Different parameters were analyzed statistically using a statistical software Statistics 8.1. Factorial design was used for measuring the level of significance by following the guidelines outlined by Steel and Torrie (2012). There were 10 measurements taken for hunter color determination and 10 panelists used for sensory evaluation. However, all the remaining data triplicates were taken.

3 | RESULTS AND DISCUSSION

3.1 | Thiobarbituric acid reactive substances (TBARS) value of raw and cooked beef patties

The statistical results in regard to TBARS estimation of raw and cooked beef patties showed significant difference with respect to treatments and storage intervals as shown in Figure 1. Higher value of TBARS was observed in raw and cooked beef patties at day 21 of storage in control, whereas minimum value was found in raw and cooked beef patties treated with WGO (4.5%) and WBF (3%) at day 0 of storage. The outcomes showed that the TBARS value was higher in cooked in contrast with the raw beef patties and value increased with the passage of storage intervals which is in agreement with the findings of Arshad et al. (2017a). The results depicted that raw and cooked beef patties have minimum TBARS value where combination of WGO (4.5%) and WBF (3%) was used and is in line with the findings of Arshad et al. (2017b) where nuggets made from wheat germ oil have minimum TBARS value.

The results are in accordance with the outcomes of Rababah et al. (2006) who believed that cooking the samples significantly (p < .05) increased the amounts of TBARS and addition of plant extracts significantly decreased the amount of TBARS value. Furthermore, our results are supported by the findings of Kumar et al. (2016) who depicted that addition of wheat bran in chicken meat biscuits significantly reduced the TBARS value during storage period. Gómez et al. (2014) demonstrated that addition of grape seed extract and conjugated linoleic acid significantly reduced the TBARS value in the low-fat beef patties.

3.2 | Peroxide value of raw and cooked beef patties

Concentration of peroxides and hydroperoxides is measured by POV which is formed during auto-oxidation of unsaturated fats in auto-oxidation reaction (Jeon et al., 2002).

POV of raw and cooked beef patties has critical impact on treatments and storage intervals. Higher value of POV in raw and cooked beef patties in control was (0.69 ± 0.05 mEq/Kg), (0.81 ± 0.04 mEq/Kg) at 21 days of storage. Figure 2 presents that the minimum value of POV was found in raw and cooked beef patties treated with WGO (4.5%) and WBF (3%) was (0.39 ± 0.02 mEq/Kg) and (0.51 ± 0.04 mEq/Kg), respectively, at 0 day of storage. The results showed that the POV significantly decreased in raw beef Patties samples as compared to cooked beef Patties samples. Besides, the POV in cooked beef Patties samples (in control condition) increased with the passage of time. The POV in raw and cooked beef Patties samples also decreased with the addition of WGO (4.5%) and WBF (3%) in both samples. The results show that the raw beef Patties have lower POV, while higher was found in cooked beef Patties (in control condition) samples.

Harcourt et al. (2003) have detailed that unsaturated fats experience loss of hydrogen upon lipid peroxidation, bringing about
the formation of a free radical at the site of unsaturation. At the point when the feedstock in which this reaction happens contains no vitamin E or other viable cancer prevention agent, the free radical is quickly changed over to a radical without unsaturated fat peroxide lastly into a hydroperoxide of the unsaturated fat. The diminished POV with expanded expansion of WGF might be because of nutrient E. (tocopherols) which are bottomless in wheat germ. Vitaglione et al. (2008) announced that germ establishes about 2.5% of grain weight and involves negligible measure of protein, yet most prominent offer of fat, nutrients particularly tocopherols.

Winkler-Moser et al. (2015) depicted that vitamin E is copious in wheat germ.

3.3 | Cholesterol contents of raw and cooked beef patties

Cholesterol is expected to keep up typical cell work in people. About 70% of the required cholesterol is blended inside, while the staying 30% originates from creature nourishments, for example, eggs.
meat items, and creature fats. However, cholesterol may experience oxidation to frame cholesterol oxidation (COP) items amid warming, presentation to light, or storage of cholesterol-containing food items (Gopalakrishnan et al., 2016).

The statistical results regarding the cholesterol content of raw and cooked beef patties tests have critical impact concerning treatments and storage interval as shown in Table 2. Higher contents of cholesterol was found in control in both raw and cooked beef patties. Whereas Table 2 showed that minimum cholesterol contents was found in raw and cooked beef patties supplemented with WGO (4.5%) + WBF (3%). The results showed that the cholesterol level significantly was reducing in raw and cooked beef patties samples with the addition of wheat germ oil and wheat bran fiber.

In concurrence with the result of Yildiz-Turp and Serdaroglu (2008) who revealed that the meat containing pre-emulsified sesame oil displacing pork fat had basically lower cholesterol substance (47.14–62.54 mg/100 g) differentiated and the control hitters which had 75.99 mg/100 g. Vegetable oils are free of cholesterol and have a higher extent of unsaturated to saturated fats than animal fats. It was also reported that lower cholesterol contents was observed in sucus with pre-emulsified hazelnut oil supplemented with 15%, 30% and half of beef fat. Additionally, comparable outcomes were watched for matured sausage in various examinations exploring the impacts of replacing pork fat/beef fat with pre-emulsified olive oil (Kayaardi & Gök, 2004; Muguerza et al., 2001).

### 3.4 pH of raw and cooked beef patties

pH is a unit of measure the degree of acidity or alkalinity of a solution is described by pH on a scale of 0 to 14. The statistical results regarding the pH value of raw and cooked beef patties samples have significant effect with respect to treatments and storage interval as appeared Table 3. Higher value of pH was observed in raw beef patties in control at 21 day of storage and higher value of pH was observed in cooked beef patties samples at 21 day of storage, whereas Table 3 presents that the minimum value was found in raw beef patties samples 0 day of storage in control and minimum value was found in cooked beef patties sample in control at 0 day of storage.

![Table 2](https://example.com/table2.png)

**Table 2** Cholesterol contents of raw and cooked beef patties treated with wheat germ oil and wheat bran fiber

| Treatments | Raw beef patties | Cooked beef patties |
|------------|-----------------|--------------------|
|            | Mean            | Mean               |
| Control    | 81.63 ± 3.15a   | 106.74 ± 3.58a     |
| WBF 3%     | 79.65 ± 2.16b   | 104.39 ± 2.84b     |
| WGO 1.5% + WBF 3% | 76.74 ± 3.59c   | 99.64 ± 3.88c      |
| WGO 3% + WBF 3% | 72.36 ± 3.68d   | 96.38 ± 4.25d      |
| WGO 4.5% + WBF 3% | 71.48 ± 4.59e   | 92.18 ± 3.26e      |

Means carrying different letters in columns differed significantly.

**Note:** The values are mean ± SD of three independent determinations.

**WBF:** Wheat bran fiber; **WGO:** wheat germ oil.

![Table 3](https://example.com/table3.png)

**Table 3** pH value of raw and cooked beef patties treated with wheat germ oil and wheat bran fiber during storage

| Treatments | Raw beef patties | Cooked beef patties |
|------------|-----------------|--------------------|
|            | 0    | 7    | 14   | 21   | Mean | 0    | 7    | 14   | 21   | Mean |
| Control    | 6.02 ± 0.02 | 6.12 ± 0.15 | 6.19 ± 0.18 | 6.26 ± 0.16 | 6.15 ± 0.18d | 6.34 ± 0.15 | 6.43 ± 0.16 | 6.52 ± 0.16 | 6.58 ± 0.06 | 6.47 ± 0.06c |
| WBF 3%     | 6.11 ± 0.06 | 6.19 ± 0.24 | 6.34 ± 0.16 | 6.37 ± 0.18 | 6.25 ± 0.05c | 6.39 ± 0.18 | 6.46 ± 0.18 | 6.49 ± 0.16 | 6.53 ± 0.25 | 6.47 ± 0.16b |
| WGO 1.5% + WBF 3% | 6.15 ± 0.05 | 6.21 ± 0.03 | 6.29 ± 0.13 | 6.4 ± 0.19 | 6.26 ± 0.18b | 6.42 ± 0.25 | 6.46 ± 0.18 | 6.52 ± 0.24 | 6.57 ± 0.23 | 6.49 ± 0.06b |
| WGO 3% + WBF 3% | 6.13 ± 0.04 | 6.26 ± 0.16 | 6.31 ± 0.05 | 6.43 ± 0.17 | 6.28 ± 0.17b | 6.38 ± 0.21 | 6.41 ± 0.25 | 6.46 ± 0.06 | 6.58 ± 0.18 | 6.46 ± 0.08b |
| WGO 4.5% + WBF 3% | 6.18 ± 0.25 | 6.22 ± 0.17 | 6.35 ± 0.09 | 6.48 ± 0.07 | 6.31 ± 0.16a | 6.45 ± 0.07 | 6.51 ± 0.21 | 6.52 ± 0.15 | 6.57 ± 0.03 | 6.51 ± 0.14a |

Note: The values are mean ± SD of three independent determinations. Means carrying different letters in columns differed significantly.

WBF: Wheat bran fiber; WGO, wheat germ oil.
**TABLE 4** L* value of raw and cooked beef patties treated with wheat germ oil and wheat bran fiber during storage

| Treatments          | Raw beef patties |          |          |          |          | Cooked beef patties |          |          |          |          |
|---------------------|-----------------|----------|----------|----------|----------|---------------------|----------|----------|----------|----------|
|                     | 0               | 7        | 14       | 21       | Mean     | 0                   | 7        | 14       | 21       | Mean     |
| Control             | 52.54 ± 2.04    | 52.69 ± 2.36 | 53.69 ± 2.11 | 53.96 ± 1.37 | 53.22 ± 1.55c | 54.69 ± 1.81 | 55.69 ± 1.46 | 56.89 ± 1.46 | 57.96 ± 1.19 | 56.31 ± 1.45c |
| WBF 3%              | 52.46 ± 1.08    | 52.85 ± 1.85 | 53.11 ± 1.55 | 53.69 ± 1.59 | 53.03 ± 1.45c | 55.64 ± 1.15 | 56.75 ± 1.35 | 57.46 ± 1.16 | 58.96 ± 1.87 | 57.20 ± 1.36b |
| WGO 1.5% + WBF 3%   | 53.89 ± 1.81    | 54.36 ± 1.58 | 54.96 ± 1.38 | 55.49 ± 1.45 | 54.68 ± 1.26b | 56.36 ± 1.26 | 57.46 ± 1.69 | 57.16 ± 2.19 | 58.46 ± 1.65 | 57.36 ± 1.37b |
| WGO 3% + WBF 3%     | 55.67 ± 1.36    | 56.96 ± 1.31 | 56.42 ± 1.24 | 57.89 ± 1.39 | 56.74 ± 1.15ab | 58.49 ± 1.11 | 59.86 ± 1.15 | 60.12 ± 2.22 | 60.49 ± 1.36 | 59.74 ± 1.16ab |
| WGO 4.5% + WBF 3%   | 56.37 ± 1.22    | 56.89 ± 2.03 | 57.96 ± 1.29 | 58.99 ± 1.16 | 57.55 ± 1.45a | 58.97 ± 1.69 | 59.49 ± 1.15 | 60.84 ± 2.12 | 61.28 ± 1.65 | 60.15 ± 1.77a |

*Note:* The values are mean ± SD of ten independent determinations. Means carrying different letters in columns differed significantly.

WBF, Wheat bran fiber; WGO, wheat germ oil.

**TABLE 5** a* value of raw and cooked beef patties treated with wheat germ oil and wheat bran fiber during storage

| Treatments          | Raw beef patties |          |          |          |          | Cooked beef patties |          |          |          |          |
|---------------------|-----------------|----------|----------|----------|----------|---------------------|----------|----------|----------|----------|
|                     | 0               | 7        | 14       | 21       | Mean     | 0                   | 7        | 14       | 21       | Mean     |
| Control             | 11.45 ± 0.21    | 12.56 ± 0.11 | 12.11 ± 0.21 | 13.65 ± 0.12 | 12.44 ± 0.14c | 13.57 ± 0.16 | 13.85 ± 0.18 | 14.59 ± 0.16 | 14.9 ± 0.16 | 14.23 ± 0.15bc |
| WBF 3%              | 11.96 ± 0.24    | 12.56 ± 0.14 | 13.25 ± 0.18 | 13.59 ± 0.08 | 12.84 ± 0.12c | 13.25 ± 0.15 | 13.49 ± 0.21 | 13.96 ± 0.13 | 14.58 ± 0.11 | 13.82 ± 0.11c |
| WGO 1.5% + WBF 3%   | 12.48 ± 0.16    | 12.86 ± 0.16 | 13.49 ± 0.25 | 13.96 ± 0.09 | 13.20 ± 0.07b | 14.78 ± 0.09 | 15.12 ± 0.23 | 15.69 ± 0.22 | 16.45 ± 0.21 | 15.51 ± 0.24b |
| WGO 3% + WBF 3%     | 12.65 ± 0.25    | 12.69 ± 0.18 | 12.88 ± 0.11 | 13.49 ± 0.11 | 12.93 ± 0.06ab | 15.49 ± 0.12 | 16.48 ± 0.14 | 16.89 ± 0.21 | 17.11 ± 0.12 | 16.49 ± 0.13a |
| WGO 4.5% + WBF 3%   | 13.98 ± 0.14    | 14.52 ± 0.24 | 14.7 ± 0.14 | 14.79 ± 0.09 | 14.50 ± 0.11a | 15.85 ± 0.04 | 16.74 ± 0.08 | 17.52 ± 0.16 | 17.89 ± 0.08 | 17.00 ± 0.11a |

*Note:* The values are mean ± SD of ten independent determinations. Means carrying different letters in columns differed significantly.

WBF, Wheat bran fiber; WGO, wheat germ oil.
The results showed that the pH value significantly decreased in raw beef patties samples as compared to cooked beef patties samples. Besides, the pH value in cooked beef patties samples (control) increased with the passage of time. The pH value in raw and cooked beef patties samples also increased with the addition of WGO (4.5%) and WBF (3%) in both samples.

The increased pH may likewise be because of the increased TVBN in light of the corruption of nitrogenous substances. Choi et al. (2008) showed that the addition of rice wheat fiber expanded the pH value. The pH of meat was higher in characterized patties with vegetable oil and rice wheat fiber than uncooked meat batter. The pH furthermore expanded when the meat batter was warmed in light of the fact that imidazolium, the essential R gathering of the amino corrosive histidine, was uncovered amid warming. So also López-Vargas et al. (2014) found a pH decline in burgers with expansion of enthusiasm organic product albedo. The pH esteems diminished amid storage time in crude and cooked beef patties. The aggregation of acids created by lactic corrosive microscopic organisms instead of vigorous microorganism may have added to the drop in pH (Beriaín et al., 2011). Hunter color value of raw and cooked beef patties.

### Table 6

| Treatments | Raw beef patties | Cooked beef patties |
|------------|-----------------|-------------------|
|            | 0               | 7                 |
|            | 14              | 21                |
|            | 34              | 41                |
| Control    | 8.66 ± 0.11     | 9.46 ± 0.21       |
| WBF 3%     | 9.46 ± 0.08     | 10.45 ± 0.25      |
| WGO 1.5% + WBF 3% | 9.45 ± 0.14 | 10.45 ± 0.21      |
| WGO 3% + WBF 3% | 9.96 ± 0.26 | 10.45 ± 0.21      |
| WGO 4.5% + WBF 3% | 10.96 ± 0.11 | 10.45 ± 0.21      |

Note: The values are mean ± SD of ten independent determinations. Means carrying different letters in columns differed significantly.

WBF, Wheat bran fiber; WGO, wheat germ oil.

3.5 | L* (lightness) value of raw and cooked beef patties

Color is the most imperative quality parameter, which is seen by shoppers at first sight. Staining is considered as the quality imperfection and it might influence agreeableness of the item. The statistical outcomes in regard to the shading estimation of crude beef patties and cooked meat patties tests have noteworthy impact as for treatments and storage interval as appeared in Tables 4–5.

Higher value of L* was observed in raw beef patties at day 21 day with addition of WGO (4.5%) and WBF (3%) and in cooked beef patties samples (61.28 ± 0.05) at day 21 with addition of WGO (4.5%) and WBF (3%), whereas Table 4 presents that the minimum value (52.46 ± 0.01) was found in raw beef patties samples at 0 day of storage with addition of WBF (3%) and minimum value was found in cooked beef patties sample in control at 0 day of storage. The results showed that the L* value significantly increased in cooked beef patties samples as compared to raw beef patties samples. Besides, the L* value in raw beef patties samples (control) increased with the passage of time. The L* value in raw and cooked beef patties samples also increased with the addition of WGO (4.5%) and WBF (3%) in both samples.

Zembayashi et al. (1999) affirmed that there was a connection (γ = 64.37–19.35x + 3.54x2, r2 = 0.79) between iron focus and L* esteem (lightness), and recommended that meat color could be improved by a decrease in iron centralization of muscle. The results acquired were in concurrence with the examination finding of (Salvador & Fiszman, 2004) who revealed that no critical change in color was found amid the storage. The incomplete substitution of meat fat by olive and linseed oils’ blend added to a fundamentally
higher L* values. A few creators have announced that fat alteration by oil is related to high daintiness of the completed item (Beriain et al., 2011; Martinez-Finkelshtein et al., 2012).

3.6 | a* (redness) value of raw and cooked beef patties

Higher value of a* in raw and cooked beef patties was observed at 21 days of storage with addition of WGO (4.5%) and WBF (3%), whereas Table 5 presents that the minimum value (11.45 ± 0.42) was found in raw beef patties samples (control) at 0 day, and in cooked beef patties, the minimum value was observed in treatment having WBF (3%) at 0 day of storage. The results showed that the a* value significantly decreased in raw beef patties samples as compared to cooked beef patties samples. Besides, the a* value in cooked beef patties samples increased with the passage of time. The a* value in raw and cooked beef patties samples also increased with the addition of WGO (4.5%) and WBF (3%) in both samples. The results showed that the raw beef patties have lower values of a*, while higher was found in cooked beef patties (control) samples.

Gili et al. (2017) revealed that the oil quality parameters showed that the raw germ had a period length of convenience of around 15 days, with the warmth treated wheat germ keeping up its quality for no under 90 days under these stored conditions. The color is a pointer of procedure quality control as brown colors increment as the tanning and caramelization responses advance. In this way, the control of color changes is by all accounts important to get good product quality. ± while a* and b* were higher. An increase in saltiness diminished (p < .01) redness (a*) of patties. Redness values of uncooked and cooked meat hatters were lower in batters formulated with vegetable oils. Comparative results were accounted for by Paneras and Bloukas (1994) for vegetable oils substituted for pork back fat in low-fat frankfurters and by Park and Park (2005) in regard to the quality properties of low-fat burger patties with included plant oils. The most reduced yellowness values were found in the control uncooked and cooked meat batters.

3.7 | b*(yellowish) value of raw and cooked beef patties

Higher value of b* in raw and cooked beef patties was observed at day 21 and at day 14 (11.82 ± 0.31) and (12.96 ± 0.33), respectively, with addition of WGO (4.5%) and WBF (3%), whereas Table 6 presents that the minimum value of raw and cooked beef patties was found and in control at 0 day of storage. The results showed that the b* value significantly decreased in raw beef patties samples as compared to cooked beef patties samples. Besides, the b* value in cooked beef patties samples in control increased with the passage of time. The b* value in raw beef patties and cooked beef patties samples also increased with the addition of WGO (4.5%) and WBF (3%) in both samples. The results show that the raw beef patties have lower values of b*, while higher was found in cooked beef patties in control samples.

Saricoban and Yilmaz (2010) reported that the increase in b* values may be due to a decrease in the content of oxymyoglobin, the major pigment responsible for the yellow color in meat products. Decreasing the b* value indicates that the meatball’s color has turned blue rather than yellow. The decrease in yellow color could be due to the decrease in oxymyoglobin content. It has been reported that the index b*, which is inversely proportional to the oxymyoglobin content, decreases at the beginning of the salting of the meat products Choi et al., (2012) studied the effects of rice bran on sensory and physicochemical properties of emulsified pork meatballs and reported that addition of wheat dietary fiber increased the b* value.

3.8 | Appearance and texture of cooked beef patties

Appearance and texture are an important quality parameter in different food commodities. Improper texture and appearance do not attract the attention of the consumers.

The statistical results regarding the appearance and texture value of cooked beef patties samples have significant effect with respect to treatments and storage interval as shown in Figure 3.

Higher value of appearance and texture was observed in control at 0 day of storage, whereas Figure 3 presents that the minimum value of appearance and texture was found in cooked beef patties treated with WGO (3%) and WBF (3%). The results showed that the appearance and textures score significantly decreased in cooked beef patties samples. The appearance and texture score in cooked beef patties samples also decreased with the addition of WGO (4.5%) and WBF (3%) in both samples. The results showed that the score for appearance and texture decreased with the passage of time or with the addition of WGO and WBF.

The results were in concurrence with Mumtaz et al. (2008), who announced in his examination discoveries that surface was influenced fundamentally amid capacity. It was bolstered by Herrero and Requena (2006), who found that the textural properties continued as before all through the storage period. Chewiness values significantly increased by fat replacers percentages increment. Also sausage prepared with hydrated wheat bran had significantly higher chewiness values than that prepared with hydrated barley whole meal. Springiness value for all sausage treatments ranged from 0.60 to 0.75 showed no significant differences between all treatments. These outcomes were in accordance with the outcomes detailed by certain specialists on various cooked sausages (Herrero et al., 2008). Our outcomes...
likewise concur with Ayadi et al. (2009) who detailed that κ/ι-carrageenan expansion to turkey sausages expanded hardness and water restricting limit.

3.9 | Taste and Odor of cooked beef patties

Taste is also an important sensory characteristic. On the tongue, it is recognized by the taste buds and odor is also very important sensory characteristic. The statistical results regarding the taste and odor value of cooked beef patties samples have significant effect with respect to treatments and storage interval as shown in Figure 3. Higher value of taste and odor was observed in control at 0 day of storage, whereas Figure 3 presents that the minimum value of taste of beef patties was found which is treated with WGO (3%) and WBF (3%) at 21 day of storage and minimum value of odor was found in cooked beef patties sample at 21 days of storage. The results showed that the texture and odor value significantly decreased in cooked beef patties samples. The taste and value of cooked beef patties samples also decreased with the addition of WGO(4.5%) and WBF (3%)in both samples. The results showed that the value of taste and appearance decreased with the passage of time or with the addition of WGO and WBF.

Beef patties formulated with wheat bran that had no adverse effects on the acceptability of their appearance, color, and their odor. Moreover, the formulation of beef patties with partial replacement of different cereal bran produced acceptable samples compared with the control in their good flavor, sufficient juiciness, consistent texture (Feiner, 2006). It has been reported that wheat fiber is neutral in taste and helps moisture and fat to produce more stable and juicy meat products (Ramadan et al., 2016).

3.10 | Overall acceptability of cooked beef patties

The overall acceptability of the cooked beef patties is also a quality index of the product. The results regarding analysis of variance for overall acceptability of the prepared patties samples are presented in Figure 3. The statistical results regarding the overall acceptability value of cooked beef patties samples have significant effect with respect to treatments and storage interval as shown in Figure 3. The higher values of acceptability showed at 0 day of storage in control. Minimum values observed in cooked beef patties at 21 day in samples which treated with WGO 4.5% + WBF 3% that depicted 5.83 ± 0.21. The trend showed the gradual decrease of scores from control to the treated samples. Similar trend was depicted by the storage days that showed lower values of taste from 0 to 21 days. However, a different behavior and trend were measured at treatment level WGO 3% + WBF 3% that deviate from general trends showed sudden increase of accessibility values at each storage day. The mean values of cooked beef patties gradually decrease at each treatment level.

The slight increment away misfortune with increment of storage period that might be because of dissipation of dampness and this concurs with the finding of Varnam et al. (1995), who detailed that for the most part the outcome showed that dampness substance of all examples diminished after storage because of vanishing misfortune ordinarily saw amid storage at two distinctive temperature, similar to the misfortune happens as aftereffect of vanishing of the water from meat surface, when brought from a virus store into conventional room temperature. An increase in the storage loss leads to decrease in moisture content. Other authors have reported no significant differences in sensory properties
(odor, color, hardness, juiciness, and fattiness) for other fresh meat products (burger patties) reformulated with a polyunsaturated gelled emulsion as a replacer for pork back fat replacer (Poyato et al., 2015).

4 | CONCLUSIONS

This study was designed to explain the influence of wheat germ oil and wheat bran fiber as fat replacers on quality and stability of low-fat beef patties. TBARS and POV for raw and cooked beef patties were found to be higher in control whereas higher value was observed in group having higher concentration of WGO and WBF. Similar trend was also observed for the cholesterol contents. pH was higher in cooked patties as compared to beef patties and showed increases with increase in WGO concentration and storage intervals. Higher score was given by the panelists to control for both raw and cooked beef patties; however, minimum score for all sensory properties was found in group treated with WGO 4.5% + WBF 3% within acceptable limit. In nutshell, raw and cooked beef patties treated with WGO 4.5% plus WBF 3% showed better quality, stability, and reduced cholesterol content.

ORCID
Muhammad Sajid Arshad https://orcid.org/0000-0001-9564-886X

REFERENCES
Ahn, D. U., Olson, D. G., Jo, C., Chen, X., Wu, C., & Lee, J. I. (1998). Effect of muscle type, packaging, and irradiation on lipid oxidation, volatile production, and color in raw pork patties. Animal Industry Report, 1(1):27–39.
Alejandre, M., Poyato, C., Ansorena, D., &Astiasarán, I. (2016). Linseed oil gelled emulsion: A successful fat replacer in dry fermented sausages. Meat Science, 121, 107–113.
AOAC (1981). Official Methods of Analysis of the Association of Official Analytical Chemists, (Ed) (13th ed). AOAC.
Arshad, M. S., Anjum, F. M., Khan, M. I., Shahid, M., Akhtar, S., & Sohaila, M. (2013). Wheat germ oil enrichment in broiler feed with α-lipoic acid to enhance the antioxidant potential and lipid stability of meat. Lipojens in Health and Disease, 12(1), 164.
Arshad, M. S., Imran, A., Nadeem, M. T., Sohila, M., Saeeda, F., Anjuma, F. M., Kwon, J.-H., & Hussina, S. (2017). Enhancing the quality and lipid stability of chicken nuggets using natural antioxidants. Lipojens in Health and Disease, 16(1), 108.
Arshad, M. S., Anjum, F. M., Khan, M. I., Saeeda, F., Imran, A., Sohila, M., Nadeem, M., & Hussina, S. (2017). Manipulation of natural antioxidants in feed to enhance the oxidative stability and quality of broiler breast meat and nuggets. Journal of Food Processing and Preservation, 41(1), e12849.
Atashkar, M., Hojatoleslami, M., & Sedaghat Boroujeni, L. (2018). The influence of fat substitution with α-carrageenan, konjac, and tragacanth on the textural properties of low-fat sausage. Food Science & Nutrition, 6(4), 1015–1022.
Ayadi, R., Schmidt, R. H., Carbo-Valverde, S., Arbak, E., & Rodriguez-Fernández, F. (2009). Investigating diversity in the banking sector in Europe: The performance and role of savings banks. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.1427753
Beriaín, M. J., Gómez, I., Petri, E., Insauti, K., & Sarriés, M. V. (2011). The effects of olive oil emulsified alginate on the physico-chemical, sensory, microbial, and fatty acid profiles of low-salt, inulin-enriched sausages. Meat Science, 88, 189–197. https://doi.org/10.1016/j.meatsci.2010.12.024
Choi, Y.-S., Choi, J.-H., Han, D.-J., Kim, H.-Y., Kim, H.-W., Lee, M.-A., Chung, H.-J., & Kim, C.-J. (2012). Effects of Laminaria japonica on the physico-chemical and sensory characteristics of reduced-fat pork patties. Meat Science, 91(1), 1–7.
Choi, Y. S., Choi, J. H., Han, D. J., Kim, H. Y., Lee, M. A., Lee, E. S., & Kim, C. J. (2008). Effects of rice bran fiber on quality of low-fat tteokgalbi. Food Science and Biotechnology, 17(5), 959–964.
Feiner, G. (2006). Meat Products Handbook: Practical Science and Technology. Sawston: Woodhead Publishing Limited.
Gili, R. D., Palavecino, P. M., Penci, M. C., Martínez, M. L., & Ribotta, P. D. (2017). Wheat germ stabilization by infrared radiation. Journal of Food Science and Technology, 54(1), 71–81.
Gómez, I., Beriaín, M. J., Sarriés, M. V., Insauti, K., & Mendizabal, J. A. (2014). Low-fat beef patties with augmented omega-3 fatty acid and CLA levels and influence of grape seed extract. Journal of Food Science, 79, S2368–S2376.
Gopalakrishnan, S., Agrawal, K., Demler, E. A., Huse, D. A., & Knap, M. (2016). Griffiths effects and slow dynamics in nearly many-body localized systems. Physical Review B, 93, 134206.
Harcourt, D. M., Rumsey, N. J., Ambler, N. R., Cawthorn, S. J., Reid, C. D., Maddox, P. R., & Umpleby, H. C. (2003). The psychological effect of mastectomy with or without breast reconstruction: a prospective, multicenter study. Plastic and Reconstructive Surgery, 111, 1060–1068.
Hemdane, S., Jacobs, P. J., Dornenz, E., Verspreet, J., Delcour, J. A., & Courtin, C. M. (2016). Wheat (Triticum aestivum L.) bran in bread making: A critical review. Comprehensive Reviews in Food Science and Food Safety, 15, 28–42.
Herrero, A. M., & Requena, T. (2006). The effect of supplementing goats milk with whey protein concentrate on textural properties of set-type yoghurt. International Journal of Food Science & Technology, 41, 87–92.
Herrero, A. M., De la Hoz, L., Ordóñez, J. A., Herranz, B., de Avila, M. R., & Cambero, M. I. (2008). Tensile properties of cooked meat sausages and their correlation with texture profile analysis (TPA) parameters and physico-chemical characteristics. Meat Science, 80(3), 690–696.
Ibarra Sáiz, M. S., Rodríguez Gómez, G., & Gómez Ruiz, M. Á. (2012). La evaluación entre iguales: Beneficios y estrategias para su práctica en la universidad: Beneficios de Peer Assessment and Strategies for Its Practice at University. Ministerio de Educación.
Jacobs, P. J., Hemdane, S., Dornenz, E., Delcour, J. A., & Courtin, C. M. (2015). Study of hydration properties of wheat bran as a function of particle size. Food Chemistry, 179, 296–304.
Jalal, H., Mir, S., Wani, S. A., Sofi, A. H., Pal, M. A., & Rather, F. (2013). Development of low fat meat products. International Journal of Food Nutrition and Safety, 4, 98–107.
Jean, N. L., Baskaran, H., Dertinger, S. K., Whitesides, G. M., van de Water, L., & Toner, M. (2002). Neutrophil chemotaxis in linear and complex gradients of interleukin-8 formed in a microfabricated device. Nature Biotechnology, 20, 826.
Jonnalagadda, S. S., Harnack, L., Hai Liu, R., McKeown, N., Seal, C., Liu, S., & Fahey, G. C. (2011). Putting the whole grain puzzle together: health benefits associated with whole grains—Summary of American Society for Nutrition 2010 Satellite Symposium. The Journal of Nutrition, 141, 1011S–1022S. https://doi.org/10.3945/jn.110.132944
Kayaardi, S., & Gök, V. (2004). Effect of replacing beef fat with olive oil on quality characteristics of Turkish soudjouk (sucuk). Meat Science, 66, 249–257.
Kumar, P., Chatli, M. K., Mehta, N., Malav, O. P., Verma, A. K., & Kumar, D. (2016). Quality attributes and storage stability of chicken meat biscuits incorporated with wheat and oat bran. *Journal of Food Quality*, 39(6), 649–657. https://doi.org/10.1111/jfq.12232

Lawless, H. T., & Heymann, H. (2013). *Sensory evaluation of food: Principles and practices*. Springer Science & Business Media.

Liu, L., Winter, K. M., Stevenson, L., Morris, C., & Leach, D. N. (2012). Wheat bran lipophilic compounds with in vitro anticancer effects. *Food Chemistry*, 130, 156–164.

López-Vargas, J. H., Fernández-López, J., Pérez-Álvarez, J. Á., & Viuda-Martos, M. (2014). Quality characteristics of pork burger added with albedo-fiber powder obtained from yellow passion fruit (Passiflora edulis var. flavicarpa) co-products. *Meat Science*, 97, 270–276. https://doi.org/10.1016/j.meatsci.2014.02.010

Martínez-Finkelsstein, A., Rakhmanov, E. A., & Suetin, S. P. (2012). Heine, G., Alemán-Mateo, H., Dávila-Ramírez, J. L., Cumplido-Barbeitia, Iasi. 178–183.

Muguerza, E., Gimeno, O., Ansorena, D., Bloukas, J. G., & Astiasarán, I. (2001). Effect of replacing pork backfat with pre-emulsified olive oil on lipid fraction and sensory quality of Chorizo de Pamplona—a traditional Spanish fermented sausage. *Meat Science*, 59, 251–258.

Mumtaz, K. A., Erasenthiran, P., & Hopkinson, N. (2008). High density selective laser melting of Waspaloy®. *Journal of Materials Processing Technology*, 195, 77–87.

Paneras, E. D., & Bloukas, J. G. (1994). Vegetable oils replace pork backfat for low-fat frankfurters. *Journal of Food Science*, 59, 725–728.

Park, H. S., & Park, Y. O. (2005). Filtration properties of electrospun ultrafine fiber webs. *Korean Journal of Chemical Engineering*, 22, 165–172.

Poyato, C., Astiasarán, I., Barriuso, B., & Ansorena, D. (2015). A new polysaturated gelled emulsion as replacer of pork back-fat in burger patties: Effect on lipid composition, oxidative stability and sensory acceptability. *LWT-Food Science and Technology*, 62(2), 1069–1075.

Rababah, T., Hettiarachchy, N. S., Horax, R., Cho, M. J., Davis, B., & Dickson, J. (2006). Thiobarbituric acid reactive substances and volatile compounds in chicken breast meat infused with plant extracts and subjected to electron beam irradiation. *Poultry Science*, 85, 1107–1113. https://doi.org/10.1093/ps/85.6.1107

Ramadan, B. R., Sorour, M. A. H., & Kelany, M. A. (2016). *Improving oxidative stability of beef burgers under chilled storage using cereal grain fractions*. University of Agricultural Sciences and Veterinary Medicine Iasi. 178–183.

Reyes-Padilla, E., Valenzuela-Melendres, M., Camou, J. P., Sebranek, J. G., Alemán-Mateo, H., Dávila-Ramírez, J. L., Cumplido-Barbeitia, G., & González-Ríos, H. (2018). Quality evaluation of low fat bologna-type meat product with a nutritional profile designed for the elderly. *Meat Science*, 135, 115–122.

Rudel, L. L., & Morris, M. D. (1973). Determination of cholesterol using o-phenthaldehyde. *Journal of Lipid Research*, 14(3), 364–366.

Salvador, A., & Fizman, S. M. (2004). Textural and sensory characteristics of whole and skinned flavored set-type yogurt during long storage. *Journal of Dairy Science*, 87, 4033–4041.

Saricoban, C., & Yilmaz, M. T. (2010). Modelling the effects of processing factors on the changes in colour parameters of cooked meatballs using response surface methodology. *World Applied Sciences Journal*, 9, 14–22.

Shantha, N. C., & Decker, E. A. (1994). Rapid, sensitive, iron-based spectrophotometric methods for determination of peroxide values of food lipids. *Journal of AOAC International*, 77(2), 421–424.

Steel, R., & Torrie, J. (2012). *Principles and procedures of statistics: A Biometrical approach*. McGraw-Hill Book Company Toronto. Revi Veteri, 13(6), 481.

Varnam, A., Sutherland, J. M., & Sutherland, J. P. (1995). *Meat and meat products: Technology, chemistry and microbiology*, Vol. 3. Springer Science & Business Media.

Vitaglione, P., Napolitano, A., & Fogliano, V. (2008). Cereal dietary fibre: A natural functional ingredient to deliver phenolic compounds into the gut. *Trends in Food Science & Technology*, 19, 451–463.

Winkler-Moser, J. K., Singh, M., Rennick, K. A., Bakota, E. L., Jham, G., Liu, S. X., & Vaughn, S. F. (2015). Detection of corn adulteration in Brazilian coffee (Coffea arabica) by tocopherol profiling and near-infrared (NIR) spectroscopy. *Journal of Agricultural and Food Chemistry*, 63, 10662–10668.

Yıldız-Turp, G., & Serdaroğlu, M. (2008). Effect of replacing beef fat with hazelnut oil on quality characteristics of sucuk–A Turkish fermented sausage. *Meat Science*, 78, 447–454.

Zembayashi, M., Lunt, D. K., & Smith, S. B. (1999). Dietary tea reduces the iron content of beef. *Meat Science*, 53, 221–226.

---

**How to cite this article**: Khalid A, Sohaib M, Nadeem MT, et al. Utilization of wheat germ oil and wheat bran fiber as fat replacer for the development of low-fat beef patties. *Food Sci Nutr*. 2021;9:1271–1281. https://doi.org/10.1002/fsn3.1988