ISSN print: 1224-5984
ISSN online: 2248-3942

Rom Biotechnol Lett. 2022; 27(3): 3466-3474
doi: 10.25083/rbl/27.3/3466.3474

Received for publication: June, 01, 2022
Accepted: July 20, 2022

Original paper

Use of Stabilized rice bran for preparing Beef Burger

HAGER IBRAHIM EL-DAKARANY[1], ABDEL MOATY EL-ABD[1], MOHAMED AHMED EL-BANA[2], MOHAMED ABDELBASET SALAMA[2], SAHAR RAMADAN ABDELHADY[3], ADEL GHAZI[3]

[1]Rice Research Section, Field Crops Research Institute, Agric. Res. Center, Giza, Egypt
[2]Food Technology Research Institute, Agricultural Research Center, Giza, 12611, Egypt
[3]Food Technology Department, Faculty of Agriculture, Kafrelsheikh University, Kafrelsheikh, 33511, Egypt

Abstract

This study was performed to investigate the effect of thermal processing (microwave oven, roasting by dry heat at 130°, for 10 and 20 min. and steaming by using an autoclave under atmospheric pressure for 10 and 20 min.) on the stability of rice bran and the utilization of microwave stabilized rice bran as fat replacers in preparing a low-fat beef burger. The obtained results revealed that: rice bran contained high levels of carbohydrates and moderate amounts of ether extract and crude protein. No differences were detected in the refractive index of rice bran oil among the stabilization procedures, whereas slight differences were found in the case of specific gravity. When rice bran oil was subjected to stabilized procedures, the acid value, iodine value, peroxide value, saponification value, and unsaponifiable matter were reduced. Moreover, the total saturated fatty acids content of rice bran oil increased as a result of subjecting to stabilization procedures whereas the total unsaturated fatty acid content decreased. The results show that stabilized rice bran is effective in improving the chemical and functional characteristics of a beef burger.

Keywords Stabilized rice bran, low-fat beef burger, fat replacer

To cite this article: EL-DAKARANY HI, EL-ABD AM, EL-BANA MA, SALAMA MA, ABDELHADY SR, GHAZI A. Use of Stabilized rice bran for preparing Beef Burger. *Rom Biotechnol Lett.* 2022; 27(3): 3466-3474 DOI: 10.25083/rbl/27.3/3466.3474

*Corresponding author: walid.metwali@agr.kfs.edu.eg

Introduction

High-fat diets are associated with several types of diseases, such as obesity, hypertension, cerebral apoplexy, myocardial infarction, diabetics, and coronary heart diseases Husak et al. [1], therefore many consumers now, are looking for no fat or low-fat versions of their traditional foods. Modern consumers interested in low-fat diets have led the food industry to develop or modify traditional food products in order to contain less fat. Rice bran has recently been used in ground beef products for both nutritive and antioxidant functionality. In addition, it possesses high levels of monounsaturated fatty acid, oleic acid, and very high levels of antioxidant compounds including tocopherols, tocotrienols, and oryzanols Godber et al. [2]. However, rice bran, a by-product of rice milling was considered unfit for prolonged storage and consumption, because of the enzyme lipase, rice bran is no longer used as waste material. The stabilized rice bran (SRB) is an allergen-free functional ingredient that can replace some of all of the traditional binders in meat products Lee et al. [3]. Moreover, rice bran is highly nutritious and hence used as a food additive. Its major use as an additive in foods is due to the dietary fibers present in it which confer upon it the characteristics of a good laxative Kim et al. [4]. Rice bran is a low-cost byproduct of rice (*Oryza sativa L.*), which is widely grown in many places of the world Rukmini, and Raghuram [5]. In 2014, the worldwide production of paddy rice exceeded 738 million metric tonnes (MMT), yielding around 70 MMT of bran FAO/UN [6]. Rice bran is a considerable byproduct of the rice milling process, accounting for 5-10% of milled rice. The bran is a good source of protein, fat, crude fiber, carbohydrates, vitamins, minerals, essential unsaturated fatty acids, and phenolics Saenjum et al. [7]. Rice bran oil is usually used as an excellent cooking medium because of its nutritional superiority, abundant micronutrients longer shelf-life stability at high temperatures, and better taste provided to food items.

The amount of rice bran components vary according to rice type, storage, climate conditions, rice bran stabilization, and processing methods Amarasinghe and Gangodavilage [8]. In addition, rice bran contains 88-89 % neutral lipids, 3-4 % waxes, 2-4 % free fatty acids, and approximately 4 % unsaponifiable Kim et al. [9]. However, because of its enzymatic activity following rice dehulling, rice bran oil's use is limited. Rice bran is abundant in lipids, and excessive lipase activity in the presence of endogenous lipoxygenase induces rancidification of these lipids Paucar-Menacho et al. [10]. Because of the lipid deterioration susceptibility of the rice bran. To avoid fatty acid release, increase shelf life, and allow commercialization for human consumption, it must be enzymatically inactivated immediately after bran extraction Herfel et al. [11]. Rice bran cannot be used as a food component because of the instability that occurs during storage. This instability refers to the lipase enzyme activity present in the outer layers of the rice kernel which is responsible for the hydrolysis of triglycerides yielding glycerol and free fatty acids. Lipoxygenase and peroxidase are also key enzymes responsible for the instability of rice bran Orthoefer [12]. Rice bran oil stands out among the healthiest and most nutritious edible oils. Rice bran oil has a fatty acid composition that is around 19% saturated (palmitic acid), 42% monounsaturated (oleic acid), and 39% polyunsaturated (linoleic acid) Mezouari et al. [13]. When compared to other vegetable oils, crude rice bran oil is noted for its relevant untraditional matter. Refined rice bran oil and crude rice bran oil may contain 1.5-2.6% and 5% unsaponifiable matter, respectively, while the unsaponifiable content of many commonly used oilseed oils is normally 0.4- 0.6% Krishna et al. [14]. Currently, there is an increased interest in the use of dietary antioxidants, including vitamins C and E, to prevent cardiovascular diseases. However, numerous natural antioxidants may be added to meat products to enhance their health advantages. Malekian et al. [15] This work was undertaken to study the possibility of using stabilized rice bran as a food additive for preparing healthy beef burgers.

Materials and methods

Materials

Rice bran samples have been collected as a byproduct of milling of a combination of three Egyptian rice (Oryza sativa L.) cultivars, namely Sakha 101, 105, and 106, which are popular short-grain japonica varieties consumed in Egypt. Rice bran samples were collected at the Rice Research and Training Center (RRTC) in Sakha, Kafrelsheikh Governorate, Egypt, during the 2020 growing season. The red muscle beef, kidney fat, and other components necessary to make beef burgers were obtained from a local market in Kafrelsheikh. The analytical grade chemicals used in the study were obtained from El-Gomhouria for Trading Chemicals and Medical Appliances in Tanta City, Egypt.

Methods

Rice bran conditioning

The full-fat raw bran was cleaned by removing the husk, and the samples collected were free of impurities.

Stabilization of rice bran

Rice bran samples were subjected to different stabilization methods as follows: the control was unstabilized rice bran (Un-RB); the first sample was stabilized by MW treatment at 900W, for 2 min. and manually mixed every minute according to Faria et al. [16]. The second and third samples were separately roasted in a hot-air oven at 130ºC for l0 min. (HAO1) and 20 min. (HAO2), respectively Bagchi et al. [17]. The fourth and fifth samples were steamed in the autoclave under atmospheric pressure for 10 min. (Autoclave 1) and 20 min. (Autoclave 2), respectively Rosniyana et al. [18]. Finally, the bran samples were stored in the dark at -10°C in water-tight containers until further analyses.

For the clearer presentation of the samples, I suggest you to insert a table and present the final notation and main parameters for each sample. These notations should be the same in all article.

Preparation of beef burger with different percentage of stabilized rice bran

Beef meat and kidney fat were grounded separately grounded in a meat grinder. The beef burger was formulated to contain: 80% grounded red beef meat, 20% grounded kidney fat, 18% (w/w) water, 1.5% salt, 0.3% black pepper (powder), 0.2% red pepper (powder) and 0.2% cumin (powder) as outlined by Aleson-Carbonell et al. [19]. Other burger formulations were added by substitution of fat at levels of 5%, 10%, 15%, and 20%) of microwave stabilized rice bran.

Gross chemical composition of the samples

Moisture, protein, ether extract, and ash contents were analyzed according to A.O.A.C. [20]. Total carbohydrates were calculated by differences.

Rice bran oil extraction

Rice bran oil was extracted from all bran samples by slurring with four volumes of food grade hexane at room temperature for 1 hr. Hexane was evaporated in a rotary evaporator at 40oC Kahlon et al. [21] .

Physical and chemical parameters of extracted oils

Rice bran oils' refractive index, specific gravity, acid value, peroxide value, iodine value, saponification value, and unsaponifiable matter were determined using the procedures described in A.O.A.C. [20].

The fatty acid profile of rice bran oil samples was determined

The methyl ester of fatty acids in rice bran oil samples was evaluated using gas chromatography (GC) in accordance with the A.O.A.C. method [20].

Beef burger cooking parameters

The beef burger studied samples were cooked using an electrical grill (Arcelik Mini Firin, Turkey) at 300 °C (the distance between heat source and the sample was 4 cm) for a total of 10 min, 6 min one side and 4 min in the other side Sorour et al. [22].

Beef burger organoleptic properties

The Sensory characteristics of the cooked burger samples were carried out by well-trained 20 panelists of Food Technology Research Institute (FTRI). Panelists were asked to evaluate color, taste, odor, texture, tenderness, and overall acceptability, of cooked samples according to the method described by Badr, and El-Waseif [23].

Statistical analysis

The data were statistically analyzed by paired samples T test analysis of variance (ANOVA) procedure with SPSS software (Version 16.0, SPSS Inc., Chicago, IL) software as described by Steel, R.G. and Torrie [24].

Results and discussion

Chemical composition of rice bran samples

Many factors influence the chemical composition of rice bran, including rice type, variance in organic compounds in the soil, fertilizer used, climatic and environmental conditions, milling degree, and treatments El-Bana et al. [25]. As a result, chemical compositions were obtained in order to investigate the previously indicated treatments and their influence on the quality of the various samples. The results presented in Table 1, shows the chemical composition of Un-RB and rice bran after the various stabilizing processes MW, HAO1, HAO2, and Autoclave 1 and 2. The moisture content values of rice bran samples were significantly different at ($P<0.05$). The moisture content of HAO2 rice bran was lower than that of Un-RB and rice bran subjected to the other stabilization procedures, this procedure may be effective for samples with a longer shelf life, less microbial contamination, and some nutrient preservation. The obtained results are in accordance with those of Abd El-Hady [26], who reported that the moisture content of stabilized oils depended on the processing temperature and duration of heating. Furthermore, moisture content plays a key role during storage Amorim et al 2004 [27]. Also shown in Table (1) the autoclaved rice bran samples (Autoclave 1 and 2) contained the highest content of crude protein contents 16.94 and 17.04 %, respectively, followed by HAO2 (16.65%) while the lowest crude protein content (15.34%) was found in the control (Un-RB). These results are in line with those obtained by Bagchi et al. [17].

Based on ether extract, Un-RB and stabilized rice bran contained 18.52 to 20.32% crude fat (Table, 1). Furthermore, stabilization by either dry or moist heat helped to in-

Table 1. Gross chemical composition (%) of rice bran after different stabilization procedures.

Treatment	Moisture	Crude Protein	Ether Extract	Ash	Carbohydrates*
Un-stabilized	8.56a+	15.34d	18.52d	8.7b	57.44a
Microwave	6.65c+	16.04c	20.32a	9.31a	54.33b
Hot Air Oven1	6.60c+	16.16c	19.42c	9.20a	55.22b
Hot Air Oven2	6.10d+	16.65b	19.82b	9.40a	54.13b
Autoclave 1	7.30b+	16.94a	19.32c	9.27a	54.47b
Autoclave 2	7.50b+	17.04a	20.02a	9.40a	53.54d

\+ Means with the same small superscript letters in a column are not significantly different at p≤ 0.05.
* Total carbohydrates were calculated by the difference.
(1) Un-stabilized (Un-RB). (2) Microwave (MW) 900 W for 2min .
(3) Hot Air Oven1 (HAO1) 130°C for 10 min. (4) Hot Air Oven2 (HAO2) 130°C for 20 min.
(5) Autoclave 1: Steaming for 10 min. (6) Autoclave 2: Steaming for 20 min.

crease the ether extract levels in rice bran. The augmentation of oil extractability could be related to the ability of heat to cause the fat in the cells to coalesce into oil droplets and break down cell structure, thereby improving the speed and extent of oil extraction, or causing degradation of lipoproteins. These results are in agreement with those reported by Vissers et al. [28]. As previously reported by other authors, different stabilization techniques play an active role in reducing enzymatic activity to a greater or lesser degree, hence, increasing or decreasing oil extraction Lakkakula et al. [29]. As shown in Table (1) the ash content of Un-RB and stabilized rice bran ranged from 8.70 to 9.0%, and the total carbohydrate content ranged from 54.13 to 57.44 %. The present findings are similar to those reported by Abd El-Hady and Bagchi et al. [26 and 17].

Physical and chemical characteristics of oils obtained from rice bran after various stabilizing processes

Physical characteristics

The physical characteristics of rice bran oil were determined, and the findings are shown in Table (2). One of the most significant physical factors used in the identification of fats and oils is the refractive index; it may be used to measure the degree of saturation of oils. There were no significant changes in the refractive index of Un-RB (1.4603) or stabilized rice bran oils (1.4671-1.5703) at (p 0.05) (Table, 2). These findings are consistent with those of Kawase et al. [30].

At 25°C, the specific gravity of oils extracted from untreated rice bran was 0.9152. These findings are consistent with those of Iskander et al. [31]. The heat treatments, specifically the MW treatment, increased the specific gravity of rice bran oil to 0.9281. Furthermore, the heat treatments had a slight effect on specific gravity. However, there is a non-linear relationship between temperature and the specific gravity of oils as found by Davies [32]. The obtained results are in agreement with those of Rizk et al. [33].

Chemical characteristics

The chemical properties of rice bran oil were determined and the results are presented in Table (2). The acid and peroxide values of oil extracted from un-stabilized (Un-RB) rice bran were (1.34% and 0.901 meq O2/kg oil), respectively. These results are comparable to those reported by Sanghi and Tiwle [34].

The heat treatments especially MW led to a decline in both acid and peroxide values. Such results may be due to the inhibition of lipase activity in rice bran by heat. Acid and peroxide values reflect oil quality degradation as a function

Table 2. Physical and chemical properties of rice bran oil after different stabilization procedures.

Parameters	Stabilization Treatments					
	Control	MW	HAO1	HAO2	Autoclave 1	Autoclave 2
Refractive index (25ºC)	1.4603a+	1.4671a	1.4603a	1.4602a	1.4602a	1.4703a
Specific gravity (25ºC)	0.9152b+	0.9281a	0.9144b	0.9162b	0.9252a	0.9201ab
Acid value (%)	1.34a+	1.11d	1.29b	1.21c	1.15d	1.13d
Peroxide value (meq/kg oil)	0.901a+	0.655e	0.838b	0.805c	0.751d	0.731d
Iodine value (gI/100g oil)	107.20a+	100.61f	106.10b	105.22c	102.10d	101.41e
Saponification value (mg KOH/g oil)	196.12a+	195.41b	195.55b	194.77c	194.10d	194.30d
Unsaponifiable matter (%)	4.52a+	4.37b	4.31b	4.19c	4.16c	4.11c

\+ Means with the same small superscript letters in rows are not significantly different at p≤ 0.05.
(1) Un-stabilized (Un-RB). (2) Microwave (MW) 900 W for 2 min.
(3) Hot Air Oven1 (HAO1) 130°C for 10 min. (4) Hot Air Oven2 (HAO2) 130°C for 20 min.
(5) Autoclave 1: Steaming for 10 min. (6) Autoclave 2: Steaming for 20 min.

Table 3. Fatty acids (%) profile of o rice bran oil after different stabilization procedures.

Fatty acid	Control*	MW oil	HAO1 oil	HAO2 oil	Auto1 oil	Auto2 oil
Myristic, C14:0	0.55	0.57	0.75	0.77	0.69	0.72
Palmitic, C16:0	17.40	17.80	19.65	19.96	19.0	19.30
Palmitoleic, C16:1	0.13	0.14	0.23	0.23	0.16	0.20
Stearic, C18:0	1.72	1.76	2.3	2.34	1.79	2.09
Oleic, C18:1	42.40	42.10	41.17	41.06	41.72	41.42
Linoleic, C18:2	36.40	36.30	34.75	34.55	35.30	35.0
Linolenic, C18:3	0.80	0.76	0.67	0.63	0.76	0.73
Eicosenoic, C20:1	0.60	0.57	0.48	0.46	0.58	0.54
TSFA** (%)	19.67	20.13	22.70	23.07	21.48	22.11
TUSFA** (%)	80.33	79.87	77.30	76.93	78.52	77.89

*- Control = oil extracted from Un-RB.

**TSFA = Total saturated fatty acids, **TUSFA = Total unsaturated fatty acids

of triacylglycerol hydrolysis and the further breakdown of hydroperoxides Nagassapa et al. [35]. Furthermore, Autoclave 2 had a stronger effect on the acid and peroxide values than Autoclave 1. In addition, autoclaving process was more effective than the use of a hot-air oven treatment. Abdel-Aal and Sosulski [36], stated that steam treating of some grains for 5 min. led to a reduction in the acid value of their oils and that steaming oat for one minute reduced the peroxidase activity to 40-60% of that in the control, moreover, the reduction reached 95% of the original activity after steaming for 3 min. Additionally, El-Sayed [37], stated that, heat treatments especially steaming, led to the decline of both acid and peroxide values, in addition to heat treatments for 20 min. were more effective than those for 10 min. The iodine value also indicates the stability of oil against oxidation, since it represents the degree of unsaturation of oils and measures their vulnerability to oxidation Nagassapa et al. [35]. The iodine values of the rice bran samples varied from 107.20 to 100.61 g /100g (Table 2). These results are comparable to those reported by Iskander et al. and Abdel-Aal, and Sosulski [31 and 36]. Furthermore, heat treatment had an obvious effect on the iodine value of rice bran oil and played an active role in decreasing the iodine value. This result could be related to the destruction of double bonds in the unsaturated fatty acids of oils as a function of heating as found by Nagassapa et al [35]. The results in Table (2) showed that the saponification values of rice bran oils ranged from 194.10 to 196.12 mg KOH/g. Crude rice bran oil contains about 96% saponifiable matter and approximately 4% un-saponifiable matter. These results are in agreement with those of Orthoefer [12]. The stabilization process especially in MW had a slight effect on the saponification value. These results are comparable to those found by El-Sayed [37], who reported that heat treatment had a small effect on saponifiable matter. In addition, the reduction of saponification value of oils as a result of heating could be attributed to the chemical reactions that led to the degeneration of products other than free fatty acids Nagassapa et al. [35]. In addition, unsaponifiable matter including hydrocarbons, sterols, vitamins, and pigments, usually play an important role in oil stability. Table (2) shows that the unsaponifiable matter of rice bran oil extracted from the Un-RB and stabilized rice bran oil samples ranged from 4.11 to 4.52%. These results confirmed that, rice bran oil has a large amount of unsaponifiable matter. The results of unsaponifiable matter content were in accordance with those reported by Kahlon et al. and El-Sayed [21 and 37].

Fatty acids composition

The results presented in Table (3) show the fatty acid composition of rice bran oil extracted from Un-RB and stabilized (MW, HAO1, HAO2, Autoclave 1 and 2) rice bran. Oleic acid (C18:1), linoleic acid (C18:2), and palmitic acid (C 16:0) are the dominant fatty acids in Un-RB, and stabilized rice bran oil were in the ranges of 41.06- 42.40; 34.55- 36.40 and 17.40- 19.96%, respectively.

The concentrations of the major fatty acids, namely C18:2, C18:1and C16:0 of the investigated rice bran oils generally agreed with those of Kahlon et al. and Amarasinghe and Gangodavilage [21 and 8], who studied the fatty acid composition of 204 rice varieties and found that the main fatty acids in rice bran oil were palmitic, oleic, and linoleic acids, which were in the ranges of 13.9–22.1, 35.9–49.2, and 27.3– 41.0%, respectively. The level of these fatty acids depends on the variety and cultivation location of the rice Gupta and Awad-Allah [38 and 39]. The reduction in oleic and linoleic acids represents a decrease in the yielded free fatty acids that might be expected during storage. Conditions especially conditions that promoting oxidation reactions. The results of the present study agree with those obtained by Krishna [40]. Concerning thermal processing, the results presented in Table (3) revealed that thermal processing of rice bran caused a decrease in unsaturated fatty

Table 4. Chemical (%) and cooking properties of beef burger supplemented with different levels of microwave stabilized rice bran.

Chemical Characteristics	Moisture	Ash	Crude Protein	Crude Fat	Carbohydrates*
Control	**57.97e	1.88e	52.70 e	23.50 a	21.92 e
5% rice bran	58.55d	2.40 d	54.80 d	18.21 b	24.59 d
10% rice bran	59.35c	2.90 c	56.95 c	14.61 c	25.54 c
15% rice bran	60.40b	3.50 b	58.10 b	11.95 d	26.45 b
20% rice bran	61.20a	4.01 a	59.29 a	9.70 e	27.00 a
cooking properties	Control	5% rice bran	10% rice bran	15% rice bran	20% rice bran
Cooking Yield%	+67.54 e	72.08 d	77.82 c	82.30 b	86.30 a
Cooking Loss%	32.46 a	27.92 b	22.18 c	17.70 d	13.70 e
Shrinkage %	25.15 a	20.86 b	16.89 c	13.89 d	11.69 e

*- carbohydrates were calculated by difference.

**Value in column with the same letters are not significantly different at p ≤ 0.5.

+- Values in rows with the same letter are not significantly different at p ≤ 0.5.

acids especially after (HAO2), while saturated fatty acids increased. In contrast, MW processing caused a slight decrease in unsaturated fatty acids. The results of the present study were in agreement with those obtained by Abd El-Hady and El-Sayed [26 and 37].

Chemical and cooking properties of beef burger supplemented with different levels of microwave stabilized rice bran

Microwave stabilized rice bran with levels 5.0, 10.0, 15.0, and 20.0 % was used in the beef burger formula, and the resultant beef burger was subjected to chemical characterization and cooking properties determination. It should be noted from the results shown in Table (4) that, the moisture content of all-beef burgers containing stabilized rice bran with levels (5.0, 10.0, 15.0 %, and 20.0 %) as fat replacer, increased significantly (p≤0.05) with increasing of replacement level of rice bran. The increment of moisture content may be due to the capability of microwave stabilized rice bran rich with fiber to hold more water via the preparation and cooking process. These results are in agreement with Ibrahium et al. and Sorour et al. [41 and 22], who stated that dietary fiber source has the capacity to hold three or four times the weight of water. For fat content of the control, the beef burger had a high amount of fat with significant difference from that of other treatments. Furthermore, the fat content of all-beef burgers containing stabilized rice bran with levels (5.0, 10.0, 15.0, and 20.0 %) decreased significantly (p≤0.05) with increasing of replacement level of stabilized rice bran. These results agree with Ibrahium et al. [41]. On the other hand, the protein content of the beef burger was increased as the replacement level increased. Furthermore, protein content percentages of beef burger samples were 52.70,54.80 56.95,59.10, and 61.30 % for the control sample and those formulated by replacing fat with levels (5.0, 10.0,15.5, and 20.0 %). These results agree with, Ibrahium et al. and Sorour et al. [41 and 22].

From analysis of data presented in the same Table (4) it could be noticed that, the ratios of replacement levels increased the total carbohydrates of samples were increased with a significant difference in comparison with the control beef burger. Meanwhile, the ash content in the beef burger formula was significant differences at p>0.05. Data of the present study are in agreement with those found by Mahmoud and Badr [42]. According to the data in Table (4), there were significant differences (P<0.05) between beef burger control and all low-fat beef burger formulas prepared with microwave stabilized rice bran for cooking properties. Apparent also from the same Table that, cooking loss of beef burgers enriched with stabilized rice bran decreased with increasing the addition levels since beef burgers enriched with stabilized rice bran had cooking loss values lower than that of control. The highest value of the cooking loss was observed with beef burger control (32.46%) while, the lowest value was observed with a low beef burger containing 20.0% microwave stabilized rice bran (13.70%). This may be related to the protein and fiber content of microwave stabilized rice bran which could influence the cooking loss of the beef burger since protein and fibers could reduce the water loss during cooking by forming gels as reported these results are in agreement with those of Choi et al. and Gibis et al. [43 and 44]. From the results presented in this Table, it could be noticed that cooking the yield of beef burgers enriched with different levels of microwave stabilized rice bran is increased with increasing the addition levels, since beef burgers enriched with microwave stabilized rice bran had cooking yield values higher than that of control. Burgers containing 20.0 % stabilized rice bran had the highest cooking yield values while the control had the lowest value. This may be related to the protein and fibers content of stabilized rice bran which could influence the cooking yield of the beef burger since protein and fibers could reduce the water loss during cooking by forming gels as reported by Choi, et al., Ibrahium et al. and Han, et al. [45 and41 and 46].

The beef burger control had the highest values of shrinkage and cooking loss (25.15 and 32.46 %). On the other hand, using microwave stabilized rice bran at different levels improved the shrinkage and cooking loss of low-fat beef burgers in compare with those of high-fat beef burger control. These results are in harmony with those of Choi et al. and Ibrahium et al. [43 and 41].

Sensory evaluation of beef burgers fortified by different levels of microwave stabilized rice bran

Fortifying meat with other non-meat ingredients has been done in the processed meat industry. This replacement is done for many reasons, such as health or economic purposes, and quality. The replacement of constituents from animal sources with those from plants has been applied in food manufacturing Egbert and Payne [47]. Data presented in figure (1) showed the sensory properties of cooked beef burger samples prepared with different levels of microwave stabilized rice bran compared with control burger samples. Results showed that there were no significant differences in the score values of taste, odor, texture, tenderness, and overall acceptability between control burgers and burgers fortified by 5, 10, or 15% of microwave stabilized rice bran. Therefore, a fortifying burger with microwave stabilized rice bran till 15 % could be suggested to be made as a burger with good quality and suitable sensorial quality . These findings are in agreement with the results of Ibrahium et al. [41] who showed that formulations of beef burgers with partial replacement of beef fat with flaxseed oil and rice bran produced acceptable samples compared to the control burger sample with a consistent texture, adequate juiciness, and good flavor. Rice fiber is neutral in taste and helps to retain moisture and fat leading to producing of a more succulent and juicy meat product Choi et al. [43] But the burgers fortified with 20% microwave stabilized rice bran were significantly different ($P < 0.05$) as compared with the other samples. With regard to the color, taste, odor, texture, tenderness, and overall acceptability, the burgers fortified with 20% of microwave stabilized rice bran had the lowest values.

Conclusions

Data obtained from this experiment indicated that un-stabilized rice bran has higher free fatty acids and can be stopped by stabilization treatment and improve oil extraction yield. In addition, microwave stabilization of rice bran has advantages over other stabilization methods. Furthermore, the beef burger that is prepared from rice bran stabilized by microwave improves chemical, cooking, and sensory properties.

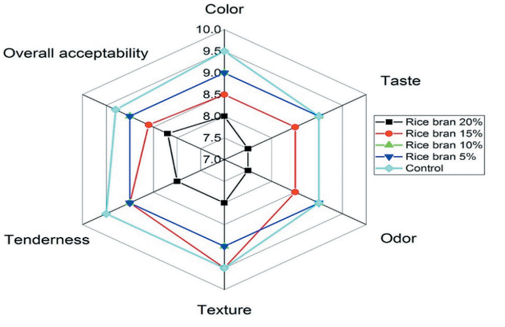

Figure 1. Organoleptic properties of beef burger supplemented with different levels of microwave stabilized rice bran.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

1. Husak, R., Prabhu, G., and Smith, R. (2018). Use of Stabilized Rice Bran as a Replacer of Modified Food Starch or Meat in Smoked Sausage. Meat and Muscle Biology, 1(2).
2. Godber, J. S., Qiao, D., Windhauser, M., and Hegsted, M. (1993). Combining rice bran and beef for improved food quality through complimentary nutritional properties. Louisiana agriculture (USA).
3. Lee, H. C., and Chin, K. B. (2010). Application of microbial transglutaminase and functional ingredients for the healthier low-fat/salt meat products: A review. Food Science of Animal Resources, 30(6), 886-895.
4. Kim, J. S., Godber, J. S., and Prinaywiwatkul, W. (2000). Restructured beef roasts containing rice bran oil and fiber influences cholesterol oxidation and nutritional profile 1. Journal of Muscle Foods, 11(2), 111-127.
5. Rukmini, C., and Raghuram, T. C. (1991). Nutritional and biochemical aspects of the hypolipidemic action of rice bran oil: a review. Journal of the American College of Nutrition, 10(6), 593-601.
6. FAO/UN (2016). FAOSTAT database: http://faostat3.fao.org/home/index.html.
7. Saenjum, C., Chaiyasut, C., Chansakaow, S., Suttajit, M., and Sirithunyalug, B. (2012). Antioxidant and anti-inflammatory activities of gamma-oryzanol rich extracts from Thai purple rice bran. Journal of Medicinal Plants Research, 6(6), 1070-1077.
8. Amarasinghe, B. M. W. P. K., and Gangodavilage, N. C. (2004). Rice bran oil extraction in Sri Lanka: Data for process equipment design. Food and bioproducts processing, 82(1), 54-59.

9. Kim, H. J., Lee, S. B., Park, K. A., and Hong, I. K. (1999). Characterization of extraction and separation of rice bran oil rich in EFA using SFE process. Separation and Purification Technology, 15(1), 1-8.
10. Paucar-Menacho, L. M., Silva, L. H. D., Sant'ana, A. D. S., and Gonçalves, L. A. G. (2007). Refining of rice bran oil (Oryza sativa L.) to preserve γ-orizanol. Food Science and Technology, 27, 45-53.
11. Herfel, T., Jacobi, S., Lin, X., Van Heugten, E., Fellner, V., and Odle, J. (2013). Stabilized rice bran improves weaning pig performance via a prebiotic mechanism. Journal of animal science, 91(2), 907-913.
12. Orthoefer, F.T., (2005). Rice bran oil. In: Shahidi, F. (Ed.), Bailey's Industrial Oil and Fat Products. John Wiley and Sons Inc., Hoboken, NY., USA.,465-489.
13. Mezouari, S., Eichner, K., Kochhar, S. P., Brühl, L., and Schwarz, K. (2006). Effect of the full refining process on rice bran oil composition and its heat stability. European Journal of Lipid Science and Technology, 108(3), 193-199.
14. Krishna, A.G.G., Khatoon, S. and Babylatha, R. (2005). Frying performance of processed rice bran oils. J. Food Lipids., 12:1–11.
15. Malekian, F., Khachaturyan, M., Gebrelul, S., and Henson, J. F. (2014). Composition and fatty acid profile of goat meat sausages with added rice bran. International journal of food science, 1-8.
16. Faria, S. A. D. S. C., Bassinello, P. Z., and Penteado, M. D. V. C. (2012). Nutritional composition of rice bran submitted to different stabilization procedures. Brazilian Journal of Pharmaceutical Sciences, 48(2), 650–657.
17. Bagchi, T. B., Adak, T., and Chattopadhyay, K. (2014). Process standardization for rice bran stabilization and its' nutritive value. Journal of Crop and Weed, 10 (2):303-307.
18. Rosniyana, A., Hashifah, M. A., and Shariffah Norin, S. A. (2009). Nutritional content and storage stability of stabilized rice bran–MR 220. Journal of Tropical Agriculture and Food Science, 37(2), 163-170.
19. Aleson-Carbonell, L., Fernández-López, J., Pérez-Alvarez, J. A., and Kuri, V. (2005). Characteristics of beef burger as influenced by various types of lemon albedo. Innovative Food Science & Emerging Technologies, 6(2), 247-255.
20. A.O.A.C. (2005). Association of Official Analytical Chemists. Official Methods of Analysis of the Association of Official Analytical Chemists.; 18thEd. Washington, DC, USA.
21. Kahlon, T. S., Chow, F. I., Sayre, R. N., and Betschart, A. A. (1992). Cholesterol-lowering in hamsters fed rice bran at various levels, defatted rice bran and rice bran oil. The Journal of nutrition, 122(3), 513-519.
22. Sorour, A. M., Salem, M. A., Arafa, S.G. and El-Bana, M.A. Chemical, physical and Sensory evaluation of low-fat beef burger with Carboxymethyl cellulose produced from rice and wheat bran. International Journal of Environment, 10 (1), 33-46.
23. Badr, S., and El-Waseif, M. (2017). Influence of Caper (Capparis spinosa L) Seeds Powder Addition as Source of Bioactive Phytochemicals on Quality Attributes and Shelf Life Extension of Beef Burger Patties. Middle East J, 6(4), 1243-1258.
24. Steel, R. G., & Torrie, J. H. (1980). Principles and procedures of statistics: a biometrical approach (Vol. 2, pp. 137-139). New York: McGraw-Hill.
25. El-Bana, M. E., Goma, R. A., and Sattar, A. S. (2020). Effect of parboiling process on milling quality, physical and chemical properties of two rice varieties. Menoufia Journal of Food and Dairy Sciences, 5(4), 35-51.
26. Abd El-Hady, S. R. (2013). Effect of some thermal processing on stability of rice bran during storage at room temperature. J. Agric. Res. Kafr El-Sheikh Univ, 39(1): 92-106.
27. Amorim, J., Eliziário, S., Gouveia, D. S. D. S., Simőes, A., Santos, J., Conceição, M., and Trindade, M. (2004). Thermal analysis of the rice and by-products. Journal of thermal analysis and calorimetry, 75(2), 393-399.
28. Vissers, M. N., Zock, P. L., Meijer, G. W., and Katan, M. B. (2000). Effect of plant sterols from rice bran oil and triterpene alcohols from shea nut oil on serum lipoprotein concentrations in humans. The American journal of clinical nutrition, 72(6), 1510-1515.
29. Lakkakula, N. R., Lima, M., and Walker, T. (2004). Rice bran stabilization and rice bran oil extraction using ohmic heating. Bioresource Technology, 92(2), 157-161.
30. Kawase, R.; Azami, S. and Maed, A. Y. (2010) Rice bran like composition and food. PCT international patent application publication. 5:1-9.
31. Iskander, M. H.; Awad, A. H. and Hamam, A. M. (1990). Effect of storage condition on the stability of fatty acid composition of corn. 1st Alex. Conf. Food Sci.Tech.,21-36.
32. Davies, R. M. (2016). Effect of the temperature on dynamic viscosity, density, and flow rate of some vegetable oils. Journal of Scientific Research in Engineering & Technology, 1(1), 14-24.
33. Rizk, L. F., Doas, H. A., and Elsakr, A. S. (1994). Chemical composition and mineral content of rice bran of two egyptian rice varieties heated by microwave. Food/Nahrung, 38(3), 273-277.

34. Sanghi, D. K., and Tiwle, R. (2015). A review of comparative study of rice bran oil and rice bran wax. International Journal of Pharmacy Review & Research, 5(4), 403-410.
35. Ngassapa, F. N., Nyandoro, S. S., and Mwaisaka, T. R. (2012). Effects of temperature on the physicochemical properties of traditionally processed vegetable oils and their blends. Tanzania Journal of science, 38(3), 166-176.
36. Abdel-Aal, E. S.M. and Sosulski, F. W. (1993). Rapid tests for residual lipase and peroxidase activities in a steam-heated cereals. Alex. Agric. Res.,38(2):161-179.
37. El-Sayed, M.E.A. (2015). Effect of some heat treatments on canola seed and rice bran characteristics. journal agricultural research kafrelsheikh university, 41(1) 246-265.
38. Gupta, H. P. (1989). Rice bran offers India an oil source. Journal of the American Oil Chemists' Society. 66(5):620-623.
39. Awad-Allah, M. M., Mohamed, A. H., El-Bana, M. A., El-Okkiah, S. A., Abdelkader, M. F., Mahmoud, M. H. and Abdein, M. A. (2022). Assessment of Genetic Variability and Bran Oil Characters of New Developed Restorer Lines of Rice (Oryza sativa L.). Genes, 13(3), 509.
40. Krishna, A.G.G. (2002). Nutritional components of rice bran oil in relation to processing. Lipid Technology, 14(4), 80-84.
41. Ibrahium, M. I., Hegazy, A. I., and El-Waseif, M. A. (2015). Effect of replacing beef fat with flaxseed oil and rice bran on nutritional quality criteria of beef burger patties. Sciences, 5(03), 645-655.
42. Mahmoud, K. A. and Badr, H. M. (2011). Quality Characteristics of gamma-irradiated beef burger formulated with partial replacement of beef fat with olive oil and wheat bran fibers, Food and Nutrition Sciences, 2: 655-666.
43. Choi, Y.S. ; Cho,i J.H. ; Han, D.J. ;Kim, H.Y. ; Lee, M.A.; Kim, H.W. ; Lee, J.W. ; Chung, H.J. and Kim, C.J. (2010). Optimization of replacing pork back fat with grape seed oil and rice bran fiber for reduced-fat meat emulsion systems. Meat Science. 84(1): 212 - 218.
44. Gibis, M., Schuh, V. and Weiss, J. (2015). Effects of carboxymethyl cellulose (CMC) and microcrystalline cellulose (MCC) as fat replacers on the microstructure and sensory characteristics of fried beef patties. Food Hydrocolloids, 45, 236-246.
45. Choi, Y. S., Choi, J. H., Han, D. J., Kim, H. Y., Lee, M. A., Kim, H. W. and Kim, C. J. (2011). Effects of rice bran fiber on heat-induced gel prepared with pork salt-soluble meat proteins in model system. Meat Science, 88 (1), 59-66.
46. Han, M., Clausen, M. P., Christensen, M., Vossen, E., Van Hecke, T., and Bertram, H. C. (2018). Enhancing the health potential of processed meat: the effect of chitosan or carboxymethyl cellulose enrichment on inherent microstructure, water mobility and oxidation in a meat-based food matrix. Food and function, 9(7), 4017-4027.
47. Egbert, W. and Payne, C. (2009). Plant proteins in ingredients in meat products: Properties, functionality and applications. Tarte, R., ed., pp. 111-129. Springer New York.