http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

OPEN ACCESS
Pakistan Journal of Biological Sciences
ISSN 1028-8880
DOI: 10.3923/pjbs.2022.993.1000

Research Article
Chemical and Sensory Evaluation of Balady Bread Supplemented with Watermelon Rinds Flour and its Anti-Hyperlipidemic Effect in Male Albina Rats

[1]H.M. Fahmy, [1]M.A. El-Waseif, [1]S.A. Badr, [1]E.I. Abd-Elazim, [1]A.M. Sabry and [2]H.A. Shaaban

[1]Department Food Science and Technology, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt
[2]Department of Chemistry of Flavour and Aroma, National Research Center, Dokki, Giza, Egypt

Abstract
Background and Objective: Watermelon is a good source of minerals, vitamins and dietary fibers. It has been considered a health benefits effect due to the high amount of antioxidants and phytonutrients such as phenolics, flavonoids, phytosterols and other medicinal compounds which decrease the risk of cardiovascular, diabetes and cancer. This research was carried out to study the effect of wheat flour (WF) supplemented with different levels of watermelon rinds flour (WRF) on the chemical and organoleptic properties of balady bread. Furthermore, the effect of prepared bread on reducing blood lipids of hyperlipidemic rats. **Materials and Methods:** Wheat flour (WF) has been supplemented with different levels (5, 10, 15 and 20%) of watermelon rinds flour (WRF). The chemical and organoleptic properties of balady bread and the anti-hyperlipidemic effect of prepared bread on hyperlipidemic rats were evaluated. **Results:** The results indicated that incorporation of WRF in balady bread wheat flour increased the fibre, ash and minerals content of prepared bread. While carbohydrates content and energy value were decreased by increasing the WRF substitution levels. Organoleptic evaluation tests showed that up to 15% of WF could be replaced with WRF in balady bread and still more acceptable bread compared with control bread samples. In addition, rats fed on a hyperlipidemic diet containing balady bread fortified with WRF showed a significant decrease ($p<0.05$) in the triglyceride (TG), total cholesterol (TC), High-Density Lipoprotein Cholesterol (HDL-C), Low-Density Lipoprotein Cholesterol (LDL-C) and Very-Low-Density Lipoprotein Cholesterol (V-LDL) level by increasing the amounts of simultaneous supplementation with WRF 5-15% in the formulated balady bread compared to control samples. **Conclusion:** The research recommended that the 15% replacement of WRF gave good quality properties and lead to reducing body weight and serum lipid profile of hyperlipidemic rats.

Key words: Balady bread, dietary fibre, health benefits, hyperlipidemic, rats, watermelon rinds

Citation: Fahmy, H.M., M.A. El-Waseif, S.A. Badr, E.I. Abd-Elazim, A.M. Sabry and H.A. Shaaban, 2022. Chemical and sensory evaluation of balady bread supplemented with watermelon rinds flour and its anti-hyperlipidemic effect in male albina rats. Pak. J. Biol. Sci., 25: 993-1000.

Corresponding Author: Hamdy A. Shaaban, Department of Chemistry of Flavour and Aroma, National Research Center, Dokki, Giza, Egypt

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Hyperlipidemia disease is defined as any disorder or elevation in one or more constituents of blood lipids including triglyceride, total cholesterol, low-density lipoprotein cholesterol and very-low-density lipoprotein cholesterol[1]. Hyperlipidemia is the main risk factor causing diabetes mellitus, fatty liver disease, cardiovascular and predictors of coronary heart disease[2,3] which considered a global cause of death in recent years[4,5]. A diet rich in cholesterol and saturated fats are the major cause of hyperlipidemic disease[6]. Consumption of foods rich in fibre such as fruits and vegetables is a major factor in improving blood lipids levels and reducing the odds of hypercholesterolemia in humans[7,8].

Watermelon (*Citrullus lanatus*) is a flowering plant with round or oblong fruits belonging to the Cucurbitaceae family which is distributed in the tropics regions and consumed all over the world[9]. The watermelon rinds are usually used in the manufacturing of feeds and fertilizer, however, it is also can be utilised in the human diet as a natural source of fibres[10]. The rinds of watermelon are a good source of minerals, vitamins and dietary fibres[11]. It has been considered a health benefits effect due to the high amount of antioxidants and phytonutrients such as phenolics, flavonoids, phytosterols and other medicinal compounds which decrease the risk of cardiovascular, diabetes and cancer[12-15]. Oral administration with methanolic extract of watermelon rinds caused a significant decrease in triglycerides, total cholesterol and low-density lipoprotein cholesterol in hyperlipidemic rats[16]. Sorour *et al.*[14] found that diabetic rats ingested with 1 mL of watermelon rind juice for three weeks induced a significant improvement in pancreatic cells compared with the normal control animals. Abu-Hiamed[17] indicated that hypercholesterolemic rats fed on a diet containing 10% watermelon rinds led to a significant decrease in serum levels of total cholesterol and LDL cholesterol.

Balady bread is the most widely daily diet consumed by almost all profiles of consumers[18]. The major ingredient in balady bread is wheat flour. Enrichment of wheat flour with fibre and protein is one of the ways to provide healthy food to consumers[19]. Al-Sayed and Ahmed[11] found that the incorporation of watermelon rinds at levels of 2.5 and 5% enhanced the nutritional and quality properties of cakes. Eshak[20] suggested that banana peels flour can be used to replace 5% up to 10% of wheat flour in balady bread as a high source of dietary fibre and minerals. Ashoka *et al.*[21] developed cookies by incorporating the watermelon rind flour at levels 10, 20 and 30% to improve the nutritional value of crude fibre and minerals content of produced cookies.

The current research was performed to study the effect of wheat flour (WF) supplemented with different levels (5, 10, 15 and 20%) of watermelon rinds flour (WRF) on the chemical and organoleptic properties of balady bread. Furthermore, the anti-hyperlipidemic effect of prepared bread on hyperlipidemic rats.

MATERIALS AND METHODS

Study area

Materials: Mature watermelon (*Citrullus lanatus*) fruits and variety (Giza 21) were purchased from the local market, in Cairo, Egypt. Wheat flour (82% extraction) was obtained from Central and West Delta Flour Mills Company, Tanta, Egypt. Instant active dry yeast and salt (sodium chloride) were obtained from the local market, Cairo, Egypt. This study was carried out at, Food Science and Technology Department, Al-Azhar University Egypt from March to September, 2021.

Experimental animals and diet: A total of 42 adult male albino rats (*Rattus Norvegicus*), weighed between 120-130 g, an average of 6-8 weeks of age were acquired from the laboratory animal station of the National Research Center, Giza, Egypt. Experimental diets including standard basal diet and hyperlipidemic diet used in this investigation[22,23], were presented in Table 1.

Chemicals: All chemicals, reagents and kits of lipids profile used in this study were of analytical pure grades and purchased from Delta Aromatic Company, Giza, Egypt.

Methods of analysis

Preparation of watermelon rind flour (WRF): The inner white rinds of watermelon were separated from the washed ripe watermelon fruits after removing the outer green skin, sliced into small pieces and dried at 50 ± 3°C for 48 hrs using a hot air oven. The dried watermelon rinds were finely milled using a conventional grinder and sieved through a 60-mesh sieve to a fine powder.

Formulation of flour blends: Five blends were prepared by incorporating watermelon rind flour (WRF) at levels 5, 10, 15 and 20% with wheat flour (82% extraction) and compared with control (100%) wheat flour (WF), these samples were depicted in Fig. 1.

Balady bread preparation: Balady bread was processed by mixing 100 g of tested flour blends with other ingredients including 0.5 g of activated dry yeast, sodium chloride and water in proportions of 1.5 g and 80 mL, respectively. This

Fig. 1: Balady bread samples investigation

Table 1: Constituents of experimental diets (%)

	Experimental diets (%)	
Ingredients	Standard basal diet	Hyperlipidemic diet
Corn starch	68	66.5
Casein	12.5	12.5
Fat (corn oil)	10	10
Cellulose	5	5
Salt mixture	3.5	3.5
Vitamins mixture	1.0	1.0
Cholesterol	-	1.0
Cholic acid	-	0.5

constituent was mixed by hand for about 7 min to form the suitable dough. The dough was left to ferment at 30°C and 85% relative humidity for one hour and then divided into 125 g pieces. The fermented dough pieces were flattened with a fine layer of bran to be about 20 cm in diameter at the same mentioned temperature and relative humidity. The flattened loaves were baked at 400-500°C for 1-2 min. The bread was cooled at room temperature for 10 min before chemical and sensory evaluation[24].

Chemical analysis of prepared bread: Moisture, protein, fat, crude fibre and ash were determined according to AOAC[25]. Total carbohydrates were calculated differently. Caloric value (Kcal) was calculated by the equation of Livesey[26] as follows:

$$\text{Total calories} = \text{Protein}\times 4+\text{fat}\times 9+\text{total carbohydrate}\times 4$$

Minerals (Ca, P, Mg, Na, K, Fe and Zn) content were determined in balady bread samples according to AOAC[25].

Sensory evaluation: The tested balady bread loaves were evaluated for their organoleptic characteristics including appearance, taste, odour, texture, crust colour, crumb distribution, separation of layers, roundness and overall acceptability. Panellists used a 1-10 point hedonic scale as follows: 10 the most liked, 5 unacceptable margins and 1 the most disliked[22,27].

Animals housing and experimental design: Forty-two adult male albino rats were used in this study and housed in plastic community cages at 23±2°C and 60±5% relative humidity with 12 hrs of light/dark cycle conditions. All rats feed on a standard basal diet during the acclimatization period (7 days) before starting the experiment. After that, the experimental animals were divided into 2 main parts: The first part (7 rats) fed on a standard basal diet only and served as a negative (-ve) control (Group 1). The second part (35 rats) were fed on a hyperlipidemic diet during the experimental period (28 days), served as (hyperlipidemic rats) and was randomly divided into equal 5 Groups (from Group 2-6) each group had 7 rats. Group (2): Hyperlipidemic rats fed on a hyperlipidemic diet only for 28 consecutive days and served as positive (+ve) control. Group (3): Hyperlipidemic rats fed on control balady bread (100% WF) for 28 consecutive days. Group (4): Hyperlipidemic rats fed on balady bread supplemented with 5% WRF for 28 consecutive days. Group (5): Hyperlipidemic rats fed on balady bread supplemented with 10% WRF for 28 consecutive days. Group (6): Hyperlipidemic rats fed on balady bread supplemented with 15% WRF for 28 consecutive days. Body weights were recorded daily during the experimental period. Bodyweight gain percentage (BWG %) was calculated as:

$$\text{BWG (\%)} = \frac{(W_2 - W_1)}{W_1} \times 100$$

Where:
W_1 = Initial body weight
W_2 = Final body weight

Blood sampling: At the end of the experiment, animals fasted for 12 hrs before sacrifice. Blood samples were collected from the heart and left to clot and centrifuged at 3000 rpm for 15 min to separate the serum and stored in Eppendorf tubes at -18°C until analysis. The liver of tested rats was removed, washed with distilled water, dried on filter paper and weighed individually to calculate the relative liver weight as (g/100 g final b.wt.) according to Elgawish and Ghanem[28].

Determination of serum lipid profile: Total cholesterol (TC) and triglycerides (TG) in blood serum were carried out according to the methods described by Danno *et al.*[29]. Serum

High-Density Lipoprotein Cholesterol (HDL-C) was measured by the colorimetric method as described by Li *et al*.[30]. Serum Low-Density Lipoprotein Cholesterol (LDL-C) was determined according to Nauck *et al*.[31]. Very Low-Density Lipoprotein-Cholesterol (VLDL-C) was calculated from the following equation:

$$\text{VLDL} - \text{C concentration} \left(\text{mg dL}^{-1}\right) = \frac{\text{TG}}{5}$$

According to Scharnagl *et al*.[32].

Statistical analysis: The obtained data were presented as means±standard error. Comparison between different groups was carried out using a One-way Analysis of Variance (ANOVA) using the SPSS computer program (version 20.0).

RESULTS AND DISCUSSION

Proximate chemical composition: The mean value of proximate chemical composition and energy value of balady bread supplemented with different levels (5, 10, 15 and 20%) of WRF were shown in Table 2. Results revealed that the protein and fat content of produced bread samples were not significantly affected by increasing the incorporation level of WRF from 5-20% as compared with control bread samples. The fibre and ash content of produced balady bread increased significantly with increasing the WRF substitution levels and the values ranged from 2.60 and 2.13% in 5% WRF to 4.81 and 3.85% in 20% WRF, respectively compared with control bread (1.89 and 1.52%, respectively). On the other hand, a gradual decrease in carbohydrates content was noticed in the same samples and reached 78.87% in balady bread samples containing 20% WRF, against 83.97% of the control sample. From Table 2, it could be demonstrated that the energy value (Kcal/100 g) was slightly and gradually decreased in tested samples and reached 374.56 Kcal in balady bread samples supplemented with 20% WRF compared with control (395.16 Kcal).

These findings were in agreement with the results of Ashoka *et al*.[21] they found that the incorporation of WRF at levels 10, 20 and 30% in cookies can improve the nutritional value of crude fibre, calcium, iron and phosphorous of produced cookies. El-Badry *et al*.[33] enhanced the nutritional value and quality properties of pan bread by replacing wheat flour with WRP up to 6% which has good quality properties and beneficial effects on human health.

Minerals content of produced balady bread: The minerals content of the control balady bread sample (100% WF) and balady bread samples containing WRF at levels of 5, 10, 15 and 20% were determined and recorded in Table 3.

As illustrated in the obtained results, it could be mentioned that the control balady bread sample contained Ca, P, Mg, Na and Fe at levels of 24.16, 174.27, 112.20, 162.30 and 2.68 mg/100 g, on a dry weight basis, respectively. The minerals content for produced balady bread was progressively increased as the replacement levels increased from WRF and reached 72.23, 197.36, 158.46, 223.65 and 4.63 mg/100 g, respectively in balady bread samples supplemented with 20% WRF.

These results were in harmony with those obtained by Olaitan *et al*.[34] they found that incorporation of watermelon rind flour with wheat flour increased the minerals content of cookies. Amal *et al*.[35] enhanced the physic-chemical and minerals content of cake samples by replacing wheat flour with watermelon rinds flour.

Sensory characteristics: The effects of watermelon rinds flour supplementation on the organoleptic characteristics of produced balady bread were presented in Table 4. As shown in the obtained results, it could be exhibited that there were no significant ($p<0.05$) differences between the control balady bread sample and a tested sample containing 5, 10 and 15% WRF in all sensory characteristics with an exception, the crust colour and crumb distribution of samples containing WRF at 15% were significantly decreased ($p<0.05$) when compared with control bread. A significant difference ($p<0.05$) was observed in bread samples enriched with 20% WRF in all sensory properties except roundness and layer separation which was not affected significantly by increasing supplementation level up to 20% WRF. The alterations in crumb distribution of bread samples containing 15% WRF may be attributed to the higher fibre content which leads to deterioration of gluten structure[36]. These results were in harmony with the results obtained by Eshak[20] and Ashoka *et al*.[21].

Effect of feeding on balady bread supplemented with WRF on body weights and liver weights of hyperlipidemic rats: Table 5 revealed that the positive control (animals group fed on the hyperlipidemic diet only) showed a significant ($p<0.05$) increase in the body weights and liver weights compared to the negative control (animals fed on a standard basal diet). Also, there were no significant ($p<0.05$) alterations in BWG and liver weights between rats of the group fed on a

Table 2: Effect of wheat flour supplemented with different levels of WRF on the chemical composition of prepared balady bread (on a dry weight basis)

	Proximate chemical composition (%)					
Bread samples	Protein	Fat	Fibre	Ash	Carbohydrates	Energy value (Kcal)
Control (100% WF)	10.86±0.01[a]	1.76±0.05[a]	1.89±0.03[e]	1.52±0.07[e]	83.97±0.27[a]	395.16
95% WF+5% WRF	10.82±0.04[a]	1.77±0.10[a]	2.60±0.08[d]	2.13±0.05[d]	82.68±0.24[b]	389.93
90% WF+10% WRF	10.78±0.20[a]	1.79±0.02[a]	3.32±0.04[c]	2.67±0.14[c]	81.44±0.37[c]	384.99
85% WF+15% WRF	10.71±0.23[a]	1.82±0.02[a]	4.06±0.07[b]	3.28±0.10[b]	80.13±0.10[d]	379.74
80% WF+20% WRF	10.63±0.16[a]	1.84±0.12[a]	4.81±0.02[a]	3.85±0.08[a]	78.87±0.02[e]	374.56

Means of three replicates±standard error, means with different superscripts within the same column differ significantly (p<0.05), WF: Wheat flour (82% extraction) and WRF: Watermelon rinds flour

Table 3: Minerals content of balady bread supplemented with different levels of WRF (on a dry weight basis)

	Minerals content (mg/100 g)				
Bread samples	Ca	P	Mg	Na	Fe
Control (100% WF)	24.16±0.57[e]	174.27±0.26[e]	112.20±1.21[e]	162.30±1.40[e]	2.68±0.02[e]
95% WF+5% WRF	35.09±1.15[d]	178.42±0.56[d]	123.50±1.04[d]	177.25±0.86[d]	3.12±0.17[d]
90% WF+10% WRF	46.27±0.46[c]	186.10±1.12[c]	134.83±0.23[c]	192.08±2.16[c]	3.74±0.08[c]
85% WF+15% WRF	58.80±2.80[b]	190.57±0.85[b]	146.10±1.15[b]	205.71±0.52[b]	4.19±0.04[b]
80% WF+20% WRF	72.23±0.35[a]	197.36±1.32[a]	158.46±0.11[a]	223.65±1.10[a]	4.63±0.12[a]

Means of three replicates±standard error, means with different superscripts within the same column differ significantly (p<0.05), WF: Wheat flour (82% extraction) and WRF: Watermelon rinds flour

Table 4: Organoleptic properties of tested balady bread supplemented with different levels of watermelon rinds flour

	Balady bread samples (M±SE)				
		Supplementation levels (%)			
Organoleptic properties	Control (100% WF)	5% WRF	10% WRF	15% WRF	20% WRF
Appearance	8.28±0.46[a]	8.25±0.73[a]	8.26±0.60[a]	8.25±0.55[a]	6.95±0.85[b]
Odor	9.15±0.26[a]	9.15±0.41[a]	9.13±0.75[a]	9.10±0.20[a]	8.50±0.36[b]
Taste	8.90±0.15[a]	8.95±0.39[a]	8.90±0.20[a]	8.92±0.10[a]	8.10±0.27[b]
Chewing ability	7.50±0.40[a]	7.50±0.06[a]	7.48±0.23[a]	7.52±0.25[a]	7.50±0.65[a]
Crust color	8.25±1.12[a]	8.20±0.86[a]	8.18±0.65[ab]	8.10±0.30[b]	7.15±0.51[c]
Crumb distribution	7.90±0.43[a]	7.84±0.90[a]	7.87±0.70[a]	6.90±0.41[b]	6.10±0.26[c]
Roundness	8.50±0.51[a]	8.65±0.28[a]	8.62±0.76[a]	8.55±0.55[a]	8.60±0.28[a]
Layer separation	8.20±0.69[a]	8.25±0.65[a]	8.33±0.24[a]	8.10±0.95[a]	8.12±0.16[a]
Overall acceptability	8.50±0.35[a]	8.50±0.18[a]	8.45±0.45[a]	8.30±0.43[a]	7.20±0.08[b]

Means±standard error, means with different superscripts within the same row different significantly (p<0.05), Control balady bread prepared from 100% wheat flour (82% extraction) and WRF: Watermelon rind flour

Table 5: Alterations in body and liver weights of hyperlipidemic rats after 28 days of being fed on produced balady bread

	Body weight (g)				Liver weight	
Animal groups	Initial	Final	BWG (g/28 days)	BWG (%)	Absolute (g)	Relative (%)
Control (+ve)	126.45±3.28[a]	202.55±2.66[d]	76.10±1.95[d]	60.18	6.92±0.28[d]	3.41
Control (-ve)	128.19±2.55[a]	275.89±2.22[a]	147.70±2.76[a]	115.21	8.24±0.35[a]	2.98
100% WF	126.82±3.06[a]	271.92±1.88[a]	145.10±3.18[a]	114.41	8.06±0.16[a]	2.96
95% WF+5% WRF	127.35±4.49[a]	265.17±1.29[b]	137.82±2.80[b]	108.22	7.83±0.08[b]	2.95
90% WF+10% WRF	128.17±3.70[a]	224.58±1.45[c]	96.41±1.32[c]	75.22	7.34±0.20[c]	3.34
85% WF+15% WRF	126.98±2.68[a]	206.13±1.38[d]	79.15±1.16[d]	62.33	7.02±0.11[d]	3.52

Means±standard error, means with different superscripts within the same column differ significantly (p<0.05), (+ve): Normal rats, (-ve): Hyperlipidemic rats, WF: Wheat flour, WRP: Watermelon rinds flour and BWG: Body weight gain

hyperlipidemic diet containing control balady bread and positive control animals. On the other side, the BWG and liver weights of hyperlipidemic rats fed on the hyperlipidemic diets enriched with balady bread composed of wheat flour and different levels of WRF decreased significantly (p<0.05) in the range from 137.82 and 7.83 g at 5% WRF to 79.15 g and 7.02 g at 15% WRF, respectively compared to the positive control (275.89 and 8.24 g). The lowest values of BWG and liver weights were achieved in the animals fed on a hyperlipidemic diet containing 15% WRF-bread formula and it was very close to the normal control animals (group 1). This increase in liver weights may be attributed to the accumulation of triglycerides

Table 6: Alterations in serum lipids level of hyperlipidemic rats after 28 days of feeding on produced balady bread

	Serum lipids profile ($mg\ dL^{-1}$)				
Animal groups	TG	TC	HDL-C	LDL-C	VLDL-C
Control (+ve)	126.26±1.98^{c}	165.10±1.65^{e}	66.25±0.32^{a}	73.12±0.82^{f}	25.25±0.08^{c}
Control (-ve)	182.66±2.40^{a}	318.75±1.23^{a}	31.98±0.18^{e}	226.58±1.24^{a}	36.53±0.15^{a}
100% WF	179.60±1.73^{a}	307.62±2.55^{a}	34.07±0.09^{e}	199.72±2.18^{b}	35.92±0.04^{a}
95% WF+5% WRF	153.44±1.72^{b}	281.10±0.92^{b}	41.20±0.25^{d}	159.14±0.51^{c}	30.68±0.10^{b}
90% WF+10% WRF	130.59±0.57^{c}	235.28±1.87^{c}	49.92±0.15^{c}	118.26±1.10^{d}	26.11±0.12^{c}
85% WF+15% WRF	128.69±2.04^{c}	180.24±2.35^{d}	60.23±0.37^{b}	92.50±0.28^{e}	25.73±0.26^{c}
Normal range ($mg\ dL^{-1}$)	<150	<200	<40	<100	<150

Means±standard error, means with different superscripts within the same column differ significantly ($p<0.05$), (+ve): Normal rats, (-ve): Hyperlipidemic rats, WF: Wheat flour, WRP: Watermelon rinds flour and control balady bread (100% WF)

as a result of an imbalance between the synthesis rate and the release rate of triglycerides by parenchymal cells in blood circulation[37].

These results were agreed with previous studies[14,17,38,39] they have indicated the ameliorative role o f watermelon rinds on body weight loss of hyperlipidemic and hypercholesterolemic rats.

Effect of feeding on balady bread supplemented with WRF on serum lipids profile of hyperlipidemic rats: The effect of feeding on a hyperlipidemic diet containing balady bread enriched with 0, 5, 10 and 15% of WRF for 28 days on contents of triglyceride (TG), total cholesterol (TC), High-Density Lipoprotein Cholesterol (HDL-C), Low-Density Lipoprotein Cholesterol (LDL-C) and Very-Low-Density Lipoprotein Cholesterol (V-LDL) of tested hyperlipidemic rats are shown in Table 6.

The obtained data revealed a significant increase ($p<0.05$) in the content of TG, TC, LDL-C and VLDL-C of hyperlipidemic rats fed on hyperlipidemic diets (-ve control) compared with normal rats fed on a basal diet (+ve control). Also, the results show that there were no significant alterations ($p<0.05$) between the corresponding parameters of hyperlipidemic rats fed on a hyperlipidemic diet (-ve control) and hyperlipidemic rats fed on balady bread containing 100% wheat flour. The results also indicated that the rats fed on a hyperlipidemic diet containing balady bread fortified with WRF (group 4, 5 and 6) by increasing the amounts of simultaneous supplementation with watermelon rinds flour from 5-15% in the formulated balady bread showed that significant decrease ($p<0.05$) in the TG, TC, LDL-C and VLDL-C level compared to control samples. The highest reductions of TG, TC, LDL-C and VLDL-C content were observed in the rats fed on a hyperlipidemic diet containing15% WRF-bread (group 6) which recorded 128.69, 180.24, 92.50 and 25.73 $mg\ dL^{-1}$ compared with 182.66, 318.75, 226.58 and 36.53 $mg\ dL^{-1}$, respectively in the positive control rats. On the other hand, serum HDL-Clevel increased significantly ($p<0.05$) from 34.07 $mg\ dL^{-1}$ in the group of rats fed on a hyperlipidemic diet containing 5% WRF bread formula to 60.23 $mg\ dL^{-1}$ in the animal group feed on hyperlipidemic diet contained 15% WRF bread formula compared with control samples.

These findings were in agreement with Abu-Hiamed[17] that the incorporation of 10% watermelon rinds into the diet of hyperlipidemic rats caused a significant decrease in TC, TG, LDL-C and VLDL-C content of tested animals. Umbreen *et al.*[40] indicated that fruit processing wastes such as mango peels and apple pomace induced anti-hyperlipidemic effects against increased lipid peroxidation, fatty liver disease and serum lipids levels in hyperlipidemic rats.

CONCLUSION

Supplementation of wheat flour with WRF greatly enhanced the fibre and minerals content for prepared balady bread. Organoleptic characteristics of produced bread revealed that up to 15% replacement of WRF gave good quality properties and lead to reducing body weight and serum lipid profile of hyperlipidemic rats.

SIGNIFICANCE STATEMENT

The study recommended that the 15% replacement of WRF gave good quality properties and lead to reducing body weight and serum lipid profile of hyperlipidemic rats by feeding it on wheat flour (WF) supplemented with different levels of watermelon rinds flour.

REFERENCES

1. Shattat, G.F., 2014. A review article on hyperlipidemia: Types, treatments and new drug targets. Biomed. Pharmacol. J., 7: 399-409.
2. Jørgensen, T., S. Capewell, E. Prescott, S. Allender and S. Sans *et al.*, 2013. Population-level changes to promote cardiovascular health. Eur. J. Preventive Cardiol., 20: 409-421.

3. Chen, G., H. Wang, X. Zhang and S.T. Yang, 2014. Nutraceuticals and functional foods in the management of hyperlipidemia. Crit. Rev. Food Sci. Nutr., 54: 1180-1201.
4. Billingsley, H.E., S. Carbone and C.J. Lavie, 2018. Dietary fats and chronic noncommunicable diseases. Nutrients, Vol. 10. 10.3390/nu10101385.
5. Skourtis, D., D. Stavroulaki, V. Athanasiou, P.G. Fragouli and H. Iatrou, 2020. Nanostructured polymeric, liposomal and other materials to control the drug delivery for cardiovascular diseases. Pharmaceutics, Vol. 12. 10.3390/pharmaceutics12121160.
6. Verma, N., 2016. Introduction to hyperlipidemia and its treatment: A review. Int. J. Curr. Pharm. Res., 9: 6-14.
7. Hong, S., Y. Song, K.H. Lee, H.S. Lee, M. Lee, S.H. Jee and H. Joung, 2012. A fruit and dairy dietary pattern is associated with a reduced risk of metabolic syndrome. Metab. Clin. Exp., 61: 883-890.
8. Yuan, C., H.J. Lee, H.J. Shin, M.J. Stampfer and E. Cho, 2015. Fruit and vegetable consumption and hypertriglyceridemia: Korean National Health and Nutrition Examination Surveys (KNHANES) 2007–2009. Eur. J. Clin. Nutr., 69: 1193-1199.
9. Tlili, I., C. Hdider, M.S. Lenucci, I. Ridah, H. Jebari and G. Dalessandro, 2011. Bioactive compounds and antioxidant activities of different watermelon (*Citrullus lanatus* (Thunb.) Mansfeld) cultivars as affected by fruit sampling area. J. Food Compos. Anal., 24: 307-314.
10. Naknaen, P., T. Itthisoponkul, A. Sondee and N. Angsombat, 2016. Utilization of watermelon rind waste as a potential source of dietary fiber to improve health promoting properties and reduce glycemic index for cookie making. Food Sci. Biotechnol., 25: 415-424.
11. Al-Sayed, H.M.A. and A.R. Ahmed, 2013. Utilization of watermelon rinds and sharlyn melon peels as a natural source of dietary fiber and antioxidants in cake. Ann. Agric. Sci., 58: 83-95.
12. Lewinsohn, E., Y. Sitrit, E. Bar, Y. Azulay and M. Ibdah *et al*., 2005. Not just colors-carotenoid degradation as a link between pigmentation and aroma in tomato and watermelon fruit. Trends Food Sci. Technol., 16: 407-415.
13. Lila, M.A., 2004. Anthocyanins and human health: An *in vitro* investigative approach. J. Biomed. Biotechnol., 5: 306-313.
14. Sorour, H.A., M.M. Selim, L.E.S. EL-Moselhy and S.G. Ahmed, 2019. Ameliorative effect of watermelon rind ingestion on the pancreas of diabetic female albino rat (histological, immunohistochemical and morphometric study). Egypt. J. Histol., 42: 10-22.
15. Ahn, J., W. Choi, S. Kim and T. Ha, 2011. Anti-diabetic effect of watermelon (*Citrullus vulgaris* Schrad) on streptozotocin-induced diabetic mice. Food Sci. Biotechnol., 20: 251-254.
16. Kolawole, T.A., S.O. Ojeka and D.V. Dapper, 2016. Anti-diabetic effects of the methanolic extract of the rind of *Citrullus lanatus* (watermelon) in alloxan induced diabetes in male albino Wistar rats. J. Med. Med. Sci., 7: 23-29.
17. Abu-Hiamed, H., 2018. Hypocholesterolemic effects of watermelon fruit rind on rats. Nutr. Food Sci., 48: 836-845.
18. Abdelghafor, R.F., A.I. Mustafa, A.M.H. Ibrahim and P.G. Krishnan, 2011. Quality of bread from composite flour of sorghum and hard white winter wheat. Adv. J. Food Sci. Technol., 3: 9-15.
19. Anjum, F.M., M.I. Khan, M.S. Butt, S. Hussain and M. Abrar, 2006. Functional properties of soy hulls supplemented wheat flour. Nutr. Food Sci., 36: 82-89.
20. Eshak, N.S., 2016. Sensory evaluation and nutritional value of balady flat bread supplemented with banana peels as a natural source of dietary fiber. Ann. Agric. Sci., 61: 229-235.
21. Ashoka, S., S.S. Begum and K.G. Vijayalaxmi, 2021. Byproduct utilization of watermelon to develop watermelon rind flour based cookies. Pharma Innovation, 10: 196-199.
22. Youssef, M.K.E., H.M.K.E. Youssef and R.M.A. Mousa, 2013. Evaluation of antihyperglycaemic activity of citrus peels powders fortified biscuits in albino induced diabetic rats. Food Public Health, 3: 161-167.
23. Watanabe, N., Y. Endo, K. Fujimoto and H. Aoki, 2006. Tempeh-like fermented soybean (GABA-tempeh) has an effective influence on lipid metabolism in rats. J. Oleo Sci., 55: 391-396.
24. Brown, J., 1993. Advances in Breadmaking Technology. In: Advances in Baking Technology, Kamel, B.S. and C.E. Stauffer (Eds.), Springer, Boston, Massachusetts, ISBN: 978-0-7514-0055-7, pp: 38-87.
25. AOAC, 2011. Official methods of analysis of AOAC International. 18th Edn., AOAC International, Gaithersburg, ISBN: 9780935584820, Pages: 25.
26. Livesey, G., 1995. Metabolizable energy of macronutrients. Am. J. Clin. Nutr., 62: 1135S-1142S.
27. El-Sohaimy, S.A., M.G. Shehata, T. Mehany and M.A. Zeitoun, 2019. Nutritional, physicochemical, and sensorial evaluation of flat bread supplemented with quinoa flour. Int. J. Food Sci., Vol. 2019. 10.1155/2019/4686727.
28. Elgawish, R.A.R. and M.E. Ghanem, 2014. Effect of long term cadmium chloride exposure on testicular functions in male albino rats. Am. J. Anim. Vet. Sci., 9: 182-188.
29. Danno, H., Y. Jincho, S. Budiyanto, Y. Furukawa and S. Kimura, 1992. A simple enzymatic quantitative analysis of triglycerides in tissues. J. Nutr. Sci. Vitaminology, 38: 517-521.
30. Li, L.H., E.P. Dutkiewicz, Y.C. Huang, H.B. Zhou and C.C. Hsu, 2019. Analytical methods for cholesterol quantification. J. Food Drug Anal., 27: 375-386.
31. Nauck, M., K. Winkler, W. März and H. Wieland, 1995. Quantitative determination of high-, low-, and very-low-density lipoproteins and lipoprotein(a) by agarose gel electrophoresis and enzymatic cholesterol staining. Clin. Chem., 41: 1761-1767.
32. Scharnagl, H., M. Nauck, H. Wieland and W. März, 2001. The friedewald formula underestimates LDL cholesterol at low concentrations. Clin. Chem. Lab. Med., 39: 426-431.

33. El-Badry, N., M.A. El-Waseif, S.A. Badr and H.E. Ali, 2014. Effect of addition watermelon rind powder on the rheological, physiochemical and sensory quality attributes of pan bread. Middle East J. Appl. Sci., 4: 1051-1046.
34. Olaitan, N.I., M.O. Eke and S.S. Agudu, 2017. Effect of watermelon (*Citrullus lantus*) rind flour supplementation on the quality of wheat based cookies. Int. J. Eng. Sci., 6: 38-44.
35. Amal, M.H, Z.E.O.M. Mohamed, N.S.Y. Hassan and E.A. El-kholany, 2017. Quality enhancing of cake using white watermelon rinds. Egypt. J. Agric. Res., 95: 1653-1667.
36. SchleiBinger, M., A.L. Meyer, N. Afsar, A.G. Nagy, V. Dieker and J.J. Schmitt, 2013. Impact of dietary fibers on moisture and crumb firmness of brown bread. Adv. J. Food Sci. Technol., 5: 1281-1284.
37. Alves-Bezerra, M. and D.E. Cohen, 2018. Triglyceride metabolism in the liver. Compr. Physiol., 8: 1-22.
38. Ridwan, R., H.R.A. Razak, M.I. Adenan and W.M.M. Saad, 2019. Supplementation of 100% flesh watermelon [*Citrullus lanatus* (Thunb.) Matsum. and Nakai] juice improves swimming performance in rats (Korean). Acad. J. Prev. Nutr. Food Sci., 24: 41-48.
39. Elsayed, M., F.E.Z. Elsherif, M. Mahran, E.S.S.A.A. Ahmed, 2021. Biochemical andnutritional studies of pulp, seeds, and peels of citron melon (*C itrullus* sp.) among obese albino rats. J. Home Econ., 4: 31-24.
40. Umbreen, H., M.U. Arshad, R. Noreen and K. Aftab, 2020. Ameliorative effect of apple pomace and mango peels against hyperlipidemia and lipid peroxidation induced by hyperlipidemic diet. Sains Malaysiana, 49: 1273-1282.