RESEARCH ARTICLE

Investigation of the Effects of Chia-fortified Basisa on Diabetic Patients

Wedad M. A. Manjil[1], Muna A. Ilowefah[2], Hanen B. Ismail[3], Hussein L. Algboory[4]

[1]Department of Home Economics, Faculty of Agriculture, University of Tripoli, Libya.
2Department of Food Technology, Faculty of Food Sciences, Wadi Alshatti University, Libya.
[3]University of Carthage, National Institute of Agronomy of Tunisia (INAT), Department of Agri-Food Industries, Tunis, Tunisia.
[3]University Tunis El Manar, Faculty of Mathematical, Physical and Natural Sciences of Tunis, Tunis, Tunisia.
[4]Faculty of Agriculture, Al-Qasim Green University, Babylon, Iraq

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ABSTRACT

It suggested that phytochemicals found in cereals, legumes and chia possess several health effects. Consequently, this study aimed to investigate the influences of chia-fortified basisa on type II diabetes, total cholesterol and triglycerides. Urea, creatinine, blood pressure and body mass index were also determined. Basisa is a cereal-legumes food that were prepared using wheat, chickpea, lentils, fenugreek, turmeric and cumin in measured ratios. Chia powder was added to basisa by 5 and 10%. The participants were diabetic (type II) with cholesterol and triglycerides elevation. They were divided into three groups according to the chia powder (0, 5 and 10%) used. The study were conducted for 90 days. The results indicated that groups who had basisa with chia had significantly ($p < 0.01$) low levels of HbA1c, cholesterol, LDL, triglycerides, BMI and blood pressure compared to the control groups after 90 days of the study. Urea and creatinine levels were increased; however, their levels were still in the normal range. It can be concluded chia powder enhanced the positive effects of basisa on chronic diseases and obesity.

Keywords: Basisa, Chia, HbA1c, Cholesterol, Triglycerides.

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INTRODUCTION

Pulses and cereals are considered essential foods worldwide, accounting for more than half of all calories and a substantial serving of protein consumption. A large evidence establishes that regular intake of pulses and whole grain products is associated with protection impacts against several chronic maladies, such as type 2 diabetes,[1] obesity,[2] cancer[3] and cardiovascular disease.[4,5]

Cereal grains represent a significant source of proteins, fibers, vitamins, minerals, and many other phytochemicals. The health benefits of whole cereals and pulses consumption could not be replicated by the intake of refined grains, which are characterized by lower levels of the mentioned functional components.[6] Bioactive molecules and phytochemicals are distinguishing of plants, and they are fundamental for maintaining human health. Cereals and pulses phytochemicals play a part as antioxidants or could have a function in maintaining and repairing DNA cells, thus, regulating cell propagation, cell differentiation, and DNA metabolism.[7] The phytochemicals that might have this role include phenolic components, terpenoids, polyphenols, phytosterols, alkaloids, carotenoids, fibers and saponins.[8]

There are some popular foods known in the Arab world that are prepared using whole cereal grains and pules and are characterized as nutritious foods. Basisa is one of the popular foods in Libya and in the Arab Maghreb in general. This type of food is usually prepared using wheat, chickpea, lentils and fenugreek and some spices as whole ingredients. Accordingly, regular consumption of such food could contribute to the mentioned health effects.

However, production techniques of basisa, such as washing, roasting and milling, might negatively impact its bioactive components.[9] For that reason, basisa supplementation with other ingredients that could be rich in vitamins, minerals and omega fatty acids after preparation would be needed. Food supplementation is one of the most important ways to obtain healthy manufactured foods, which benefit in reducing food shortages and overcoming hidden hunger locally and on a global scale.[10]

Chia seeds and its powder has been largely studied due to its growing popularity and acceptance as a healthy food choice.[11] Therefore, it might be an appropriate ingredient to fortify basisa and enhance its nutritional value, without affecting the sensory properties of the fine product.[12] Additionally, many

**Author for Correspondence: mona.milad2005@mail.com*

studies reported that diet rich in chia powder led to an increase in the high-density lipoprotein and omega-3 fatty acids, and a decrease in the levels of triglyceride and diabetes disorders in the serum of mice.[13] Moreover, chia seeds are rich in protein, ash, omega fatty acids and some vitamins.[14] Therefore, the current investigation aimed to study the effects of chia-fortified basisa consumption on type II diabetes, total cholesterol and triglycerides. Moreover, urea, creatinine, blood pressure, waist circumference (WC) and body mass index (BMI) were also determined.

MATERIALS AND METHODS

Materials

Wheat, chickpea, lentils, fenugreek, turmeric, cumin and chia seeds were purchased from the supermarket in Tripoli, Libya. All the used chemicals were obtained from Sigma.

Basisa Preparation

The ingredients of basisa were cleaned, washed, dried and then roasted. The ingredients included wheat, chickpea, lentils, fenugreek, turmeric and cumin, were mixed as 4, 1.5, 2 kg, 50, 50, and 1.5 g, respectively. Thereafter, the mixture of the ingredients was milled to a fine powder. Chia seeds were milled to a fine powder and added to the basisa by 5 and 10%. These chosen quantities were according to the basisa type prepared in Tripoli city that have the highest acceptance in terms of sensory properties (data not shown) among other types of basisa.

Experimental Design

This study was conducted during the period from January to March 2022, for a period of 90 days. The study was performed at Diabetes and Endocrinology Hospital and Tripoli Medical Hospital, Tripoli, Libya. The investigation involved twenty men and women aged between 30 to 50 years old. The participants were suffering of type II diabetes and cholesterol elevation with normal blood pressure. They were divided into three groups according to the levels of chia used in the basisa samples (0, 5 and 10%). Basisa samples were mixed with water (1:10) and given to the patients once daily, before breakfast. The dosages were according to the body weight, while taking their usual medications. All the procedures were under the supervision of specialist doctor and a nutritionist, with an organized nutritional program.

Body mass index

BMI was calculated according to the following equation: BMI = weight (kg) / square length (m^2) (Owaida, 2009).

Blood pressure measurement

Blood pressure was measured by a manual mercury sphygmomanometer (date 1977, China).

Blood sugar determination

The Accu Chek device determined blood sugar (Roche 2020, Germany).

Biochemical tests

The biochemical tests, which included fasting sugar, hemoglobin binding sugar (HbA1c), total cholesterol, triglycerides, low-density lipoproteins, urea and creatine, were determined by utilizing COBAS-INTEHGRA-400-Pius device (Wytec, Portugal, 2017).

Statistical analysis

The data were statistically analyzed using SPSS 16 (USA). The statistic performed on the data were: Paired T-test and T-test Independent.

RESULTS AND DISCUSSION

Type II Diabetes

It can be observed that consumption of chia-fortified basisa significantly reduced fasting sugar ($p < 0.01$). Table 1 showed the decrease rate in the fasting sugar level in the participants, who consumed basisa without chia, was 0.045%. Whereas, the groups who took basisa having 5 and 10%, the decline rate in their fasting sugar level were 15 and 23%, respectively. Accordingly, chia powder effectively reduced glucose levels in the type II sugar patients.

The same trend can be seen for HbA1c (Table 1). HbA1c significantly diminished after consuming basisa in the all studied groups. However, the reduction in the level of HbA1c in the groups, who consumed basisa with chia powder was significantly ($p < 0.01$) higher than the level of the individuals, who took basisa without chia. It has been accepted that HbA1c indicates glycemic control and is the best indicator for diabetic microvascular problems. Clinically, it is now utilized to evaluate glycemic control in individuals with diabetes.[15] The intake of whole grains and pulses that are low-medium in glycemic index, is believed to reduce the risk of type II diabetes or help preventing the disease occurrence based on their bioactive component and fibre contents through improving insulin sensitivity and glucose metabolism.[16] It was also found that adding chia to a diet of fifteen healthy participants effectively converts glucose into a slow-release carbohydrate and greatly influences satiety.[17] It was reported that rats consuming great fat and fructose diet and substituting soybean oil with a 13.3% chia seeds had greater tolerance of glucose and insulin than the control.[18] It was indicated that individuals consuming bread substituted with chia seeds recorded lower postprandial glycemia compared to individuals, who consumed bread free of chia and this impact was dose-dependent.[19] Previous studies indicated that whole cereal grains, legumes and chia seeds can help in prevention or controlling glucose level in the type II diabetes, this study could prove this fact through the synergistic effect between chia powder and whole cereal grains and legumes.

Lipid profile

In general, total cholesterol, LDL and triglycerides were significantly decreased in all studied groups ($p < 0.01$) (Table 2). The average level of total cholesterol was diminished in the subjects who consumed basisa with 5% chia from 184.3 to 146.6 mg/dL, compared to the subjects, who consumed 10% of chia-fortified basisa, which significantly decreased from 177.0 to 149.2 mg/dL. The reduction in the cholesterol proportion in

Table 1: Effect of basisa and chia-fortified basisa on type II diabetes

	Beginning of the study	*End of the study*	*P-Value*
Chia ratio	Fasting sugar (mg/dL)		
0%	178.5 ± 13.2	177.7 ± 12.1	0.01*
5%	154.9 ± 16.1	131.2 ± 10.2	0.044*
10%	178.1 ± 22.1	135.8 ± 12.3	0.022*
Chia ratio	HbA1c (mg/dL)		
0%	9.11 ± 0.581	8.953 ± 0.415	0.001*
5%	8.283 ± 0.558	7.492 ± 0.514	0.001*
10%	8.275 ± 0.694	7.124 ± 0.414	0.001*

HbA1c: hemoglobin binding sugar, *Significant difference at the level ($p < 0.01$).

the groups who consumed basisa with chia was higher than that of the individuals who took basisa without chia. Basisa with 5% chia was more effective in reducing cholesterol level than basis having 10% chia powder. It was reported that chia powder added to basisa was effective in lowering cholesterol in individuals with type 2 diabetes.[20] This is consistent with what was mentioned by,[21] who pointed out that chia seeds have a positive effect in lowering blood fats, especially in cases with hyperlipidemia.

The results of this investigation also indicated that the rate of LDL cholesterol significantly decreased in patients who consumed basisa with 5 or 10% chia powder from 134.1 to 104.3 mg/dL and from 121.75 to 104.83 mg/dL, respectively (Table 2). It was established that lentil and chickpea proteins were effective in lowering plasma VLDL-C and liver triglyceride concentrations, in addition to decreasing lipoprotein lipase action in epididymal fat and elevating hepatic lipase activity in rats in comparison to casein control group.[22] The ingredients of basisa has both lentil and chickpea, in addition to chia powder.

The triglycerides of the participants were also measured (Table 2). The subjects ate basisa with 5% chia powder their triglycerides level at the beginning of the study was 115.9 mg/dL and at the end of 90 days it was 113.8 mg/dL. This result pointed out that there was no significant difference in triglycerides among the subjected. Whereas triglycerides in people who consumed basisa with 10% chia powder at the beginning of the study were 150.8 mg/dL, then they significantly declined to 117.3 mg/dL ($p < 0.01$). A study indicated that legume rich diet lowered the total and LDL-cholesterol.[23] Whole grains and pulses consist abundance of bioactive components, like dietary fibre, resistant starch, tocols, mono- and polyunsaturated fats, plant sterols and isoflavones, which have been presented with beneficially alteration in lipid metabolism.[24] Also,[25] indicated that chickpea peptides effectively reduced the total serum triglyceride and the total and low-density lipoprotein cholesterol while increasing high-density lipoprotein cholesterol levels in obese rats given rich-fat diet. A study compared groups of rats consuming casein as a protein source and groups of rats with chia seeds or chia flour. The results of that investigation stated that the groups receiving chia flour or seeds showed lower blood concentrations of total cholesterol, low-density lipoproteins, triglycerides and very low-density lipoproteins compared to the control that consuming casein.[26]

Table 2: Effect of basisa and chia-fortified basisa on lipid profile

	Beginning of the study	*End of the study*	*p-value*
Chia ratio	Cholesterol		
0%	190.7 ± 12.3	188.9 ± 9.9	0.014*
5%	184.3 ± 11.8	146.6 ± 9.0	0.002*
10%	177.0 ± 10.6	149.2 ± 9.5	0.019*
Chia ratio	LDL lipoprotein		
0%	139.3 ± 12.7	138.6 ± 11.8	0.01*
5%	134.1 ± 13.5	104.3 ± 8.7	0.001*
10%	121.75 ± 9.24	104.83 ± 7.01	0.040
Chia ratio	Triglycerides		
0%	118.2 ± 13.4	117.88 ± 12.0	0.013*
5%	115.9 ± 14.1	113.8 ± 13.0	0.845
10%	150.8 ± 29.7	117.3 ± 20.3	0.016*

*Significant difference at the level ($p < 0.01$).

Blood pressure rate

Blood pressure decreased after 90 days of consuming basisa with 5 or 10% chia powder. However, there were not significant differences between the subjects, whether in the systolic or diastolic pressure (Table 3). The reason might be that the diastolic and systolic pressures were in the normal range, where it is previously stated that the ideal pressure rates are less than 120 for the systolic pressure and less than 80 for the diastolic pressure.[27] Whole-grain products and their substances have been constantly found to provide a cardioprotective influence.[28] Consumption of whole grain fibers declined the risk of coronary artery disease and atherosclerosis development. A study indicated that legume-rich diet lowered the total and LDL-cholesterol; it was the only dietary approach in the investigation that reduced blood pressure.[23] There was a study conducted on twelve healthy volunteers displayed that the administration of chia seeds by 50 g every day for one month contributed to a reduction in diastolic blood pressure and a decrease in the concentration of blood triglyceride.[30]

Table 3: Effect of basisa and chia-fortified basisa on blood pressure

Chia ratio	*Systolic*		
	Beginning of study	End of study	P-value
0%	124.05 ± 3.08	122.32 ± 2.10	0.323
5%	122.08 ± 5.05	115.42 ± 2.08	0.087
10%	119.75 ± 2.15	117.50 ± 1.79	0.332
Chia ratio	Diastolic		
	Beginning of study	End of study	P-value
0%	78.80 ± 3.25	76.00 ± 1.03	
5%	75.00 ± 1.05	74.17 ± 1.49	0.586
10%	80.92 ± 3.20	77.50 ± 2.50	0.469

Urea and creatinine levels

The current study's findings revealed that consuming basisa with or without chia powder caused an elevation in the urea and creatinine levels (Table 4). However, the levels of both parameters were in the normal level. It has been indicated that the normal range of creatinine should not exceed 1.4 mg/dL for men, and 1.2 mg/dL for women, while urea should be between 15–45 mg/dL.[31] A study reported that chia extract reduced the levels of urea acid and creatinine levels.[31] In general, urea level affect by the amount of consumed protein, basisa is rich in protein, due to the ingredients used (chickpea, lentils and fenugreek) in its preparation, which could cause an increment in the urea level.[32]

Physical body measurements

Table 5 presented that patients with the control basisa sample led to a non-significant decrease in the weight and W.C. However, the reduction in the BMI was significant ($p < 0.01$). Consumption of whole grains not only prevent diabetes incidence, but it also benefits in controlling the related factors, like obesity and overweight.[33] Increment consumption of cereal and pulse proteins has been revealed to elevate satiety and help control weight.[34] Consumption of basisa was more effective in reducing weight, W.C and BMI as observed in the patient groups who consumed basisa with 5 or 10% chia powder. It is expected, because of the synergistic effect between the bioactive components of basisa ingredients and chia. It was observed that the entire studied sample of patients, their appetite for food decreased with having chia-fortified basisa during the study period. The reason might be the high fiber content in the basisa meal.[35] These fibers are characterized as being devoid of calories, and delay the emptying of the stomach from food and help to feel full and reduce the need to eat more food.[16]

The observational trials have indicated that a reverse correlation was found between obesity factors and whole grain rich diets.[36] The mechanisms involved with that effect might be that whole grain rich diet stimulates satiety, which reduces food consumption.[37] It is believed that the bioactive compounds existed in chia seeds could be used to supplement food, in addition to being utilized as a vehicle to increase the amount or number of vital nutrient consumption.[38]

Table 4: Effect of basisa and chia-fortified basisa on urea and creatinine

Chia ratio	*Urea*		
	Beginning of study	*End of study*	*P-value*
0%	25.32 ± 1.09	26.88 ± 1.63	0.01*
5%	21.92 ± 1.08	25.83 ± 1.56	0.001*
10%	25.25 ± 2.03	26.46 ± 2.78	0.695
Chia ratio	Creatinine		
	Beginning of study	End of study	P-value
0%	0.916 ± 0.312	0.964 ± 0.293	0.335
5%	0.6000 ± 0.0348	0.6417 ± 0.596	0.339
10%	0.875 ± 0.251	0.925 ± 0.292	0.365

*Significant difference at the level ($p < 0.01$).

Table 5: Effect of basisa and chia-fortified basisa on weight, W.C and BMI

Chia ratio 0%			
Parameters	*Beginning of the study*	*End of the study*	*P-value*
Weight	72.16 ± 7.87	71.58 ± 6.77	0.093
W. C	103.58 ± 2.45	103.06 ± 3.18	0.837
BMI	34.36 ± 2.24	33.29 ± 2.29	0.020
Chia ratio 5%			
	Beginning of the study	End of the study	*P-value*
Weight	75.86 ± 4.41	71.58 ± 3.85	0.048*
W. C	92.46 ± 3.82	86.63 ± 3.17	0.012*
BMI	29.13 ± 1.96	29.04 ± 2.00	0.339
Chia ratio 10%			
	Beginning of the study	End of study	*P-value*
Weight	81.03 ± 4.97	78.50 ± 5.18	0.006*
W. C	104.92 ± 8.81	99.58 ± 9.36	0.152
BMI	33.51 ± 2.42	32.38 ± 2.44	0.002*

W.C: waist circumference, *Significant difference at the level ($p < 0.01$).

CONCLUSIONS

It can be concluded that basisa with chia powder effectively reduced blood sugar, cholesterol, triglycerides, LDL and BMI levels in type II diabetes. Thus, basisa having chia powder can be considered a functional food. More studies are needed to determine its impacts on other diseases and conditions.

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