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Original Article

Glycemic, insulinemic and triglyceride responses of individuals with type 2 diabetes to bread types

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Abstract

Study Aims: Supporting the formation of an adequate and balanced diet and personal healthy eating habits in individuals with diabetes and having fiber in their diets as much as their requirements is an important step in regulating blood glucose levels and preventing complications caused by diabetes. If bread, which is one of our main food sources, is made from flour with high fiber content, and therefore, its glycemic index is lower, if portion control is also provided, it provides support for better control of blood glucose in individuals with diabetes.This study was planned to determine the differences between blood glucose, triglyceride and insulin responses against different bread types and to determine the effects of fiber amounts in bread on these difference. *Methods:* 50 people with Type 2 DM between 30-60 years of age, who do not use insulin and HBA1C levels are ≤ 7% with body mass index at most 29.9 kg / m², was selected on a voluntary basis from patients at Cyprus Famagusta State Hospital Nutrition and Dietetics policlinic. Anthropometric measurements of individuals , 24-hour food consumption records and face-to-face survey method, blood tests (total cholesterol, HDL cholesterol, LDL cholesterol, VLDL cholesterol, ALT, AST, Hb A1C) were used to determine nutritional status. After analyzing energy, carbohydrate, protein, fat, total fiber, soluble and insoluble fiber contents of white bread, whole grain bread, whole wheat bread and diabetic bread (The analyzed breads were bought from a private bakery that volunteered to analyze the breads they produced.) in TUBITAK food analysis laboratories, it was determined how many grams of bread contains 50 grams of carbohydrates. The bread variety to be compared(which were bought from the bakery) was consumed with 500 ml of water in 15 minutes at the latest and at the 30th, 60th, 90th and 120th minutes, blood glucose values were measured with the same glucometer. In addition, insulin and triglyceride levels in fasting and 120. minutes were examined in a private laboratory (immuno essay analyzer) with blood samples taken from the blood collection department of Famagusta State Hospital. A one-week break was given for the tests to be made with each type of bread. *Results:* The average age of the individuals participating in the study was found to be 43.02 ± 9.86 years. 40% of individuals are men and 60% are women. When the blood results were examined, the average HbA1C value of men was 6.4 ± 0.4% and women was 6.3 ± 0.4%. According to the results of the analysis, bread with the highest fiber level (11.47 g / 100g) and the lowest carbohydrate level (37.32 g / 100 g) is diabetic bread. The distributions of the differences between blood sugar values at the time of fasting and 120. minute of different bread varieties were examined. It was observed that the blood sugar value in white, whole wheat and whole grain bread increased at 120 minute, while the blood sugar value decreased in diabetic bread. Insulin difference of diabetes bread being lower than all other bread types were found statistically significant ($p < 0.001$). The triglyceride value of diabetes bread at 120 minutes was lower than the triglyceride value of all other bread types ($p < 0.001$) which found statistically significant. *Conclusions:* As a result, it shows that bread with high fiber content will contribute significantly to the daily fiber requirement, thereby contributing to the control of postprandial glucose, postprandial insulin and triglyceride levels.

Keywords: Fiber, Bread Types, Insulin, Triglyceride, Glycemic Control

Introduction

Diabetes is a metabolic disease that causes acute, metabolic and chronic degenerative complications, which results in hyperglycemia, which causes the human organism's inadequate use of carbohydrates, fats and proteins, resulting from insulin deficiency, definite or relative insufficiency of insulin secretion, insulin inefficiency, and requiring continuous medical treatment (1,2). Medical nutrition therapy is an effective method in the prevention and treatment of diabetes or complications related to diabetes (3,4,5,6). Supporting the formation of individual healthy eating habits is an important step in regulating blood glucose levels and preventing complications caused by diabetes. Medical nutrition therapy can decrease A1C levels around 1-2% in people with type 2 diabetes (3,5). HBA1C levels of individuals with Type 2 diabetes in which glycemic control is achieved and blood glucose levels are regulated are targeted as ≤ 7% (3,7). It is stated that high-fiber diet has beneficial effects on insulin and blood glucose. In the medical nutrition treatments of individuals with diabetes, it is recommended to prefer fiber-rich and low-glycemic load carbohydrate sources such as vegetables, fruits, legumes, whole grains and dairy products instead of sugar (8).

The amount of fiber is important in the diet of individuals with diabetes.14 g / 1000 kcal fiber is recommended for individuals with diabetes (3). As a source of fiber, vegetables and fruits, whole grain cereals, dried legumes are recommended every day (3,7,8). It is stated that the foods with high fiber content have low glycemic indexes, and the fact that the presence of fiber in nutritional treatments for individuals with diabetes helps in controlling blood glucose and that high total dietary fiber intake increases the insulin sensitivity and prevents the development of Type 2 diabetes (3,9,10,11).

Consumption of fiber as much as each individual needs, contributes to sustainability of healthy life and protection from chronic diseases. (10). The concept of glycemic index was first introduced in 1981 to compare the effect of certain foods on blood sugar response. Whole grain components, including fiber, resistant starch and oligosaccharides in the digestive system, are the primary source of providing intestinal homeostasis. Studies indicate that increasing grain and whole grain consumption from grains increases fecal volume, water absorption and partial fermentation of fiber in the colon, and oligosaccharides increase the number of beneficial bacteria in the feces. Resistant starch goes directly to the column, fermentation here and fulfills its duty by acting just like soluble diet fiber.

Bread is the main food source of all humanity. Therefore, it is emphasized that bread made from flour with high fiber amount has a lower glycemic index and better control of blood glucose in diabetic individuals consuming this type of bread, but consequently portion control is important (12,13).

Aim of the study

This study was planned to determine the differences between the blood glucose, triglyceride and insulin responses against white bread, diabetic bread, whole wheat bread and whole grain bread and to determine the effects of the amount of fiber in bread on these differences for individuals with Type 2 diabetes between 30-60 years of age.

Materials and Methods

The individuals participating in this study were those who applied to the Famagusta State Hospital Nutrition and Dietetics policlinic in 2019, who were 30 to 60 years old (40% of individuals are men and 60% are women) with insulin-free Type 2 diabetes, whose blood glucose levels were regulated, and that had HBA1C levels ≤ 7%, 50 individuals on a voluntary basis, who do not use drugs other than oral antidiabetics (antihyperlipidemic and / or antihypertensive), have no gastrointestinal health problem, and have a Body Mass Index (BMI) of ≤ 29.9 kg / m² (taking into account the obesity classification of the World Health Organization) was selected. Before starting the study, an application was made to the Eastern Mediterranean University Ethics Committee and written approval (number: ETK00-2017-0081) was obtained. In the selection of individuals, the universe was created on the basis of volunteering. 'Informed

Volunteer Consent Form' was signed to all individuals who volunteered to participate in the study. It has been paid attention that individuals do not use antihypertensive or antihyperlipidemic drugs other than glucophage. After biochemical tests of the individuals, face-to-face questionnaires were made, 24-hour food consumption records were taken and anthropometric measurements were made. Individuals participating in the study were asked to measure their glucose before going to bed at night, and if their blood sugar was between 90-140 mg / dl, they were asked to fast for 8 hours until morning.

Assessment of anthropometric measurements

In the scope of the research; body weight (kg), body fat mass (kg), lean body mass (kg), total body water (kg) and BMI (kg/m²) were measured with the Bioelectric Impedans Analysis-Tanita MC 780 weighing device and the height (cm) and waist circumference (cm) were measured by the inelastic tape measure. Average BMI and waist circumferences were given in the table 1. Individuals must be hungry before weighing, they did not take alcohol and caffeine in the last 24 hours, they were barefoot and they wore lightweight clothes, and a measurement of 0.5 kg tare was made.

The evaluation of nutrition status

24-hour food consumption records and face-to-face survey method were used to determine the personal information and nutritional status of individuals. At this stage, illustrated food catalogs were used (14). Nutritional status was determined by determining the nutrient consumption levels of the individuals using food consumption records, taking anthropometric measurements, and collecting the disease histories and biochemical findings.

Analysis of breads to be used in the study

The breads to be compared were prepared in a special oven in accordance with the Turkish Food Codex bread and bread variety notification (15) and after analyzing the amounts of energy, carbohydrates, protein, fat, total fiber, soluble and insoluble fiber in TUBITAK food analysis laboratories, bread weights containing 50 g of carbohydrates were determined exactly and consumed to individuals included in the study. The nutrient contents of the analyzed breads are shown in Table 3. According to the results of the analysis, the bread with the highest fiber level (11.47 g / 100g) and the lowest carbohydrate level (37.32 g / 100 g) is diabetic bread (Table 3). The analyzed breads were bought from a private bakery that volunteered to analyze the breads they produced. It was decided to analyze the bread they put on the market by calling it diabetic bread, which is made by bringing a flour mixture from Europe and has no white flour added, at the volunteer bakery with the suggestions of the managers. Diabetic bread is made from rye and whole grain flour. In other breads used in the study, a certain amount of white flour was used in accordance with the codex.

Biochemical measurements

Before the study, blood tests were performed to determine the biochemical blood results (total cholesterol, HDL cholesterol, LDL cholesterol, VLDL cholesterol, ALT, AST, Hb A1C). All stages such as requesting of blood tests by internal medicine specialists and taking blood in the blood collection section, analyzing them in the Biochemistry Laboratory (using clinical chemistry analyzer with photometry method) were carried out in Famagusta State Hospital. Individuals who agreed to participate in the study were asked to stay hungry for 8 hours from night to morning before donating their blood, as the participants in the study were individuals with Type 2 diabetes, they were recommended to check their blood sugar with their own glucometer devices and if their blood glucose are between 90-140 mg / dl, they are recommended to stay hungry and prevent hypoglycaemia. After fasting for 8 hours, the fasting blood glucose values of individuals were measured with a glucometer (On-Call Redi glucometer device) consumed and the type of bread to be compared was with 500 ml of water at the latest in 15 minutes, and at the 30th, 60th, 90th and 120th

Table 1. Distribution of Average Values of the Age, BMI, Waist Circumference and Blood Results of the Individuals by Gender

	Men		Women		Total		*p*
	N	$\bar{X}$ ± SD	*N*	$\bar{X}$ ± SD	*N*	$\bar{X}$ ± SD	
Age (year)	20	42.5±11.6	30	43.4±8.7	50	43.0±9.9	0.539**
BMI (kg/m²)	20	25.5±3.7	30	24.4±3.8	50	24.8±3.7	0.309*
Waist circumference (cm)	20	96.7±12.8	30	85.9±12.2	50	90.2±13.4	0.004*+
Blood Results							
Cholesterol (mg/dl)	20	200.8±18.1	30	196.2±20.5	50	198.0±19.5	0.422*
HDL (mg/dl)	20	42.4±7.1	30	44.5±7.2	50	43.6±7.1	0.309*
LDL (mg/dl)	20	126.9±18.9	30	121.0±20.0	50	123.4±19.6	0.302*
VLDL (mg/dl)	20	27.6±11.9	30	28.9±11.3	50	28.4±11.5	0.692**
ALT (u/L)	20	21.6±13.5	30	20.2±6.7	50	20.7±9.9	0.858**
AST (u/L)	20	20.9±6.3	30	23.0±11.3	50	22.1±9.6	0.698**
HBA1C (%)	20	6.4±0.4	30	6.3±0.4	50	6.3±0.4	0.668*

$\bar{X}$: Average; SD: Standart deviation; *: Student's T Testi; **: Mann Whitney U Test; + : $p \leq$ 0,05

minutes, blood glucose values were measured with the same glucometer. Patients whose fasting blood glucose levels were below 70 mg / dl were excluded from the study to prevent the risk of hypoglycaemia during the study. In addition, insulin and triglyceride levels in fasting and 120. minutes were examined in a private laboratory (immuno essay analyzer) with blood samples taken from the blood collection department of Famagusta State Hospital. As long as blood collection procedures continued, patients were under the supervision of an internal medicine specialist and diabetes nurses at the Diabetes Department of Famagusta State Hospital. Individuals took oral antidiabetic medications after their blood was taken at 120. minutes. As soon as the last blood sample was taken at 120. minutes, individuals have breakfast and then take the medication they had to take. A one-week break was given for the tests to be made with each type of bread.

Statistical evaluation

Research data was uploaded to computer environment with SPSS 20 (Statistical Package for Social Sciences) program and evaluated. Descriptive statistics are presented as mean ± standard deviation, frequency and percentage. While comparing qualitative data, "Chi-Square Test", "Fisher's Exact Test" although the number of observations is insufficient, "Student's t Test" if parametric assumptions are not provided, "Mann Whitney U Test" used as statistical method. If the two groups are dependent, "Wilcoxon Matched-Paired Sign Ranked Test" was used when comparing the averages. If there is three or more groups "One way ANOVA" used as statistical method. Statistical significance level was accepted as "p≤0.05"

Results

A total of 50 people aged between 30-60 years were included in the study. The average age of these people was 43.02 ± 9.86 years. 40% of individuals are men and 60% are women. Some general information about the individuals participating in the study is given in Table 1. The average age of the individuals is 42.5 ± 11.6 years in males, 43.0 ± 9.9 years in females, the average waist circumference of men is 96.66 ± 12.79 cm, women are 85.93 ± 12.16 cm, and BMI values of men are 25.5 ± 3.7 kg / m² and women are 24.4 ± 3.8 kg / m² (Table 1). The distribution of the values of the blood results of the individuals included in the study are also shown in Table 1. When the blood results were examined, the average HbA1C value of men was 6.4 ± 0.4% and 6.3 ± 0.4% for women. 27 of the individuals stated that they had diabetes for less than 5 years, 18

Table 2. Average Bread Consumption in Individuals According to Gender (gr).

	Men		Women		Total		*p*
	N	$\bar{X}$ ± SD	*N*	$\bar{X}$ ± SD	*N*	$\bar{X}$ ± SD	
Breakfast	20	66.3±16.77	30	54.2±18.66	50	59.0±18.74	**0.029**
Lunch	20	65.0±14.95	30	49.2±17.96	50	55.5±18.41	**0.003**
Dinner	20	57.5±16.42	30	48.3±18.49	50	52.0±18.09	0.112
Snacks	20	20.0±20.84	30	13.3±18.26	50	16.0±19.4	0.220

$\bar{X}$*:* Average; SD: Standart deviation; *p*: Mann Whitney *U*

Table 3. Nutrient analysis results in 100 gr of bread varieties.

	White Bread	Wholegrain bread	Whole weat bread	Diabetic Bread
Energy (kcal) (Atwater Method)	276	242	256	224
Moisture (g) (AOAC Official Method 925.1)	30,24	37,42	34,33	38,51
Ash (g) (AOAC Official Method 923.03)	1,84	1,86	1,53	1,95
Protein (g) (AOAC Official Method 960.52)	8,12 (N*5,80)	8,64 (N*5,80)	8,35 g (N*5,80)	8,95 (N*5,80)
Carbohydrate (g) (Atwater Method)	57,34	46,67	50.47	37,32
Diet Fiber (g) (AOAC Official Method 991.43)	1,16	4,00	3,82	11,47
Fat (g) Tecator Soxhlet system HT Application)	1,30	1,41	1,50	1,80
Soluble Diet Fiber (g) (AOAC 991.43,1994)	< 0,65	< 0,65	< 0,65	< 0,65
Insoluble Diet Fiber (g) (AOAC 991.43,1994)	1,16	4,00	3,82	11,47
The amount of bread containing 50 gr CHO (g)	87	107	99	134

of them for 5-10 years and 5 of them for more than 10 years. The majority (59.3%) of those who have diabetes for less than five years are women. 60% of people who have had diabetes for more than ten years are men. There was no significant relationship between diabetes ages and gender (p> 0.05). All 50 people with diabetes reported using drugs. The drug used differs in different doses of the same product. Most people use Metformin 850 mg. 54.5% of those using this drug are women and 45.5% are men. The majority of women use Metformin 500 mg and Metformin 1000 mg. There was no statistically significant difference between drug and gender distributions (p> 0.05). According to the distribution of the type of bread consumed by individuals, it was determined that 21 people preferred whole grain bread, 13 people preferred rye bread, 11 people preferred whole whet bread, and 5 preferred white bread. 61.9% of those who prefer whole grain bread are women and 38.1% are men. There was no statistically significant difference between bread types and gender

distributions (p> 0.05). The averages of the amount of bread consumed in the meals are given in Table 2. While men eat an average of 66.3 grams of bread for breakfast, women eat 54.2 grams of bread. The amount of bread consumed by men compared to women was found statistically significant (p <0.05). The amount of bread consumed at lunch was also different for men and women (p <0.05). The distribution of the amount of bread eaten in the evening and snacks is similar (p> 0.05). The distributions of the differences between blood sugar values at the time of fasting and 120. minutes of different bread types were examined. When the distributions of the differences in blood sugar values were compared between the four bread groups, it was found to have a different distribution from each other (p <0.05). It was observed that the blood sugar value in white, whole wheat and whole grain bread increased at 120. minutes, while the blood sugar value decreased in diabetic bread. In pairwise comparisons between bread varieties, the blood sugar differences of the individuals at 0. min and 120. min were examined and blood sugar values were not found to be different between the whole wheat bread and whole grain bread consumption, but in the comparisons between other bread varieties, the blood sugar values were different from each other (p <0.05) (Table 4). The distributions of the differences between insulin values at the time of fasting and 120. minutes of different bread types were examined. When the distributions of the differences between the insulin values were compared between the four bread types, they were found to have different distributions (p <0.05). Insulin value at the time of fasting was lower for all breads. As a result of the pairwise comparisons, the distribution of insulin difference between whole grain bread and whole wheat bread was found to be similar (p> 0.05). The difference in insulin in individuals who consume diabetic bread is lower than the insulin difference of all other types of bread, which was statistically significant (p <0.001). The diabetic bread's mean insulin difference between 0 min and 120. min is 11.9 ± 12.8 μIU / ml and has a lower difference than the other three types of bread. (Table 4). The distribution of the differences of triglyceride values at the time of fasting and 120. minutes of different bread varieties were examined. When the distributions of the differences of triglyceride values were compared among the four bread types, it was found to have a different distribution (p <0.05). While the average triglyceride value decreased at 120. minutes in diabetic, whole wheat and whole grain bread, it was observed that it increased in white bread. As a result of the pairwise comparisons, the distributions of the difference between whole grain bread and whole wheat bread and whole wheat bread and white bread were found to be similar (p> 0.05). The triglyceride value of diabetic bread at 120. minutes was lower than the triglyceride value of all other bread types (p <0.001). The mean difference of triglyceride values of diabetic bread at 0 and 120. minutes was -33.8 ± 29.6 mg / dL, statistically significantly different from the other three types of bread. (Table 4).

Discussion

Type 2 diabetes is the most common type of diabetes in the world and in our society (16). Nutrition programs for individuals with diabetes should definitely be planned individually. Providing the amount of fiber and fiber from whole grains is very important in ensuring glycemic control (17). For this reason, the distribution of macronutrients in the nutrition plan should be individualized in accordance with the nutritional habits, preferences and metabolic goals of the individual with diabetes. Very low-carbohydrate diets are not recommended if the daily intake of carbohydrates is below 130 g and thus causes insufficiency of many nutrients that are sources of vitamins, minerals, fiber and energy (2,18). All fibers can slow the absorption of sugar and fat from food, and therefore help prevent spikes in blood sugar and blood fat after eating, possibly reducing the inflammatory response to food. Fiber can also prevent the absorption of some fat and cholesterol all together, lowering blood triglyceride and cholesterol levels (17). Particularly soluble fiber has a blood glucose lowering effect. The fiber extends the duration of gastric emptying by forming gel and slows the absorption of carbohydrates by increasing intestinal transit rate. In addition, non-digestible starch in the small intestine passes into the colon and is digested by bacteria and excreted with feces. According to the results of the study conducted on diabetic individuals,

it was found that diabetic people with moderate level of carbohydrate and high amount of fiber consumption has lower postprandial plasma glucose level, serum triglyceride, total and LDL cholesterol levels than diabetic with low fiber consumption.Therefore, it is emphasized that the daily fiber intake of diabetic individuals should be 25-50g (or> 14g / 1000 kcalories) and the foods with low glycemic index should be preferred (11,18). In this study, the glycemic and acute effects on triglycerides in individuals with diabetes, of different bread types which have a very important place in our diet, were evaluated (18). In both insulin-dependent and non-insulin dependent diabetic patients, a high-carbohydrate diet does not offer any advantage in terms of blood glucose and plasma lipid concentrations compared with a high-fat (mainly unsaturated) diet. It has been shown repeatedly that a high-carbohydrate diet increases plasma insulin A high-carbohydrate/high-fiber diet significantly improves blood glucose control and reduces plasma cholesterol levels in diabetic patients compared with a low-carbohydrate/low-fiber diet (17,18). *T*he breads were analyzed in Tubitak Mam research center and the fiber amount in 100 g was examined.All the individuals participating in the study consumed the amount of bread that was adjusted according to the weight of 50 grams of carbohydrate. White bread, whole wheat bread, whole grain bread and diabetic bread were used in the study. The fiber amounts of each bread are different and the diabetic bread is highest. As a result of consumption of the breads,it was once again demonstrated that the amount of fiber positively affects the glycemic control which was detected during the postprandial blood glucose monitoring.In a study conducted by Junyi and his friends in China, 934 type 2 diabetic individuals and 918 healthy individuals were studied. As a result of the food consumption frequency survey applied in individuals with diabetes whose fasting plasma glucose, HbA1C levels, triglyceride levels and BMI are higher than healthy individuals, It has been determined that fasting plasma glucose, HbA1C levels, triglyceride levels and BMI are lower in diabetic individuals who are fed a diet containing high fiber, low glycemic index and low glycemic load (19). In a study by Abuteir et al., the effects of soluble fiber on glycemic control in individuals with Type 2 diabetes were examined. In this study conducted in 42 individuals with type 2 diabetes, individuals with diabetes were divided into 2 groups. One group was given 10.5 g of water-soluble fiber for 8 weeks, while the other group continued their normal diet. A significant improvement was observed in BMI, HbA1C, C-Peptide, Homa IR and Homa-B values of the group supplemented with fiber (20). While some studies have indicated that soluble fiber types are more effective in lowering glucose and insulin levels than insoluble fiber types (21,22), some other studies have indicated that insoluble fiber types may also be effective in reducing blood glucose and insulin levels. (23,24). In our study, it was determined that the bread types analyzed contain more insoluble fiber especially in whole wheat bread (4.0 g) and diabetic bread (11.42 g) than the soluble fiber. According to the results of the study, the distributions of the differences in blood glucose values measured after consumption of bread, at the time of fasting and at the 120th minute were examined.When the distributions of the differences in blood glucose values were compared between the four bread types, it was found to have a different distribution from each other ($p < 0.05$). In white, whole wheat and whole grain bread, the average blood glucose value at 120. minutes was higher than the time of fasting, while the average blood glucose value in diabetic bread decreased at 120. minutes (Table 4). When the mean values of insulin at the time of fasting and 120. minutes were compared between the four bread types,which was found to be different from each other ($p < 0.05$) (Table 5). The average insulin difference of diabetic bread was statistically significantly lower than all other bread types ($p < 0.001$). This result supports that the high amount of insoluble fiber in diabetic bread is important in blood glucose and insulin control. In the study carried out by Breen et al., 66 men and 44 women with an average age of 66.5 years were consumed various breads while hungry. According to fasting values, blood glucose levels were measured every half hour up to the 2nd hour, and individuals were followed by looking at fasting insulin and 2nd hour postprandial insulin levels. Pumpernickel bread is the highest amount of fiber (19.2 g- bread containing 50 g of carbohydrates), it has been found to have a lower peak in glucose results compared to all other types of bread and has a lower peak in insulin

Table 4. Comparison of the Difference Between Individuals' Blood Sugar (mg / dl), Insulin ((μIU / ml) and Triglyceride (mg / dl) Values at 0. min and 120. min According to Bread Types (mg)

	$\bar{X}$ ± SD	*p*	LSD Test
Blood Glucose			White Bread – Whole wheat bread 0.177
White Bread	14.4±28.7	<0.001	White Bread– Diabetic bread <0.001
Whole Wheat Bread	7.9±26.3		White Bread – Whole grain bread 0.020
Diabetic Bread	-9.4±15.2		Whole wheat bread – whole grain bread 0.324
Whole Grain Bread	3.1±24.5		Whole wheat bread – Diabetic bread <0.001
			Diabetic bread – Whole grain bread 0.010
Insulin			White Bread – Whole wheat bread 0.047
			White Bread– Diabetic bread <0.001
White Bread	29.6±19.7	<0.001	White Bread – Whole grain bread 0.010
Whole Wheat Bread	22.9±17.3		Whole wheat bread – whole grain bread 0.552
Diabetic Bread	11.9±12.8		Whole wheat bread – Diabetic bread 0.001
Whole Grain Bread	20.9±16.3		Diabetic bread – Whole grain bread 0.008
Triglyceride			
			White Bread – Whole wheat bread 0.007
White Bread	17.9±109.8	<0.001	White Bread– Diabetic bread <0.001
Whole Wheat Bread	-15.8±31.9		White Bread – Whole grain bread 0.003
Diabetic Bread	-33.8±29.6		Whole wheat bread – whole grain bread 0.770
Whole Grain Bread	-19.4±33.5		Whole wheat bread – Diabetic bread 0.146
			Diabetic bread – Whole grain bread 0.244

$\bar{X}$: Average; SD: Standart deviation; *p*: One Way ANOVA

results compared to white bread and whole grain bread(13). Chandalia et al conducted a study with 13 people with Type 2 diabetes, followed by 2 different diet models. In one of these diets, each of which lasts for 6 weeks, 8 g of soluble and 16 g of insoluble fiber, a total of 24 g of fiber, as recommended by the American Diabetes Association (ADA), In the second, the diet content was prepared as high fiber (25 g soluble, 25 g insoluble pulp, 50 g in total). At the end of 6 weeks, it was found that preprandial glucose levels decreased by 13 mg / dl, total cholesterol levels by 6.7%, triglyceride levels by 10.2% and LDL levels by 12.5% in those with high fiber diet (25). In our study, the distributions of the differences in the triglyceride values of different bread types at the time of hunger and at the 120th minute were examined. When the averages of the differences in triglyceride values were compared between the four bread types, it was found that they were different from each other (p <0.05). In diabetic, whole wheat and whole grain bread, it was observed that the average of triglyceride at 120th minute decreased, while white bread increased. It was found statistically significant that the triglyceride value of individuals who consume diabetic bread was lower than the triglyceride value of all other bread types at 120 minutes (p <0.001). The average triglyceride difference between 0. min and 120. min of diabetic bread is -33.8 ± 29.6 mg / dL and has a higher difference than the other three types of bread (Table 6). As we can see from the bread analysis results, diabetic bread is the bread type with the highest insoluble fiber content (11.47 g). In a study by Giacco et al., 61 men and women aged 40-65 years with a diagnosis of metabolic syndrome were given a diet rich in whole grains (40.2 g / day) and as a control, diets rich in refined grains (22.1 g / day) were used for 12 weeks. At the end of 12 weeks, plasma insulin (29%) and postprandial triglyceride (43%) concentrations were found to be lower in the group consuming high whole grain

(26). In the study conducted by Hannon et al., 117 people with a metabolic syndrome were given a diet rich in fiber (20.2 ± 7.5 g / day). As a result of the study, a positive correlation was found between total fiber consumption and postprandial triglyceride (27). In a metaanalysis involving 27 studies by Reynolds et al., High-fiber diet applications were found to reduce triglyceride concentrations (28). In another study conducted by Li et al in rats, the hypoglycemic and hypolipidemic effects of soluble and insoluble fiber in type 2 diabetic individuals were examined.As a result of the study, they stated that they found evidence supporting the hypoglycemic and hypolipidemic effects of insoluble fiber and soluble fiber in diabetic rats (29).

Conclusion

As a result, bread consumption causes big question marks among individuals with Type 2 DM against the information pollution that occurs today. The main purpose of this study was to provide scientific support to these questions, and the results of the study proved that bread with sufficient fiber content can be consumed by individual portion planning. It also shows that bread with high fiber content will make a significant contribution to the daily fiber requirement and thus contribute to the control of postprandial glucose, postprandial insulin and triglyceride levels. Besides adequate and balanced energy intake, a nutrition program that can be applied by the person with diabetes, suitable for individual needs, makes a significant contribution to the type 2 DM treatment process. The medical nutrition therapy program, supported by nutrition education, will contribute to the acquisition of behavior change (30,31).

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Conflict of interest: None

Ethical Standards Disclosure: This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures were approved by the **Eastern Mediterranean University Scientific Research and Publication Ethics Committee (project number: ETK00-2017-0081).** Written informed consent was obtained from all subjects.

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