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ORIGINAL STUDY

FOOD EFFECTS ON THE HEALTH OF PATIENTS WITH DIABETES

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ABSTRACT

According to the data from the World Health Organization, 240 million people with diabetes live worldwide nowadays. According to forecasts, this number will increase up to 380 million in the next 20 years. At the moment, it is estimated that the spread rate of diabetes among children and adolescents increases by 3% per year, while among preschoolers by 5% per year. At present, it has been established that type 2 diabetes is also increasing among young people and adolescents. In Romania (Bucharest region) the incidence of diabetes is estimated at 5.6/100.000.Based on these considerations and on the fact that diabetes may be regarded as a system disease, affecting many organs and systems, it follows that one of the main problems of the diabetic patient is represented by food. In this respect, we wanted to make a type of bread which could also be consumed by diabetics, without changing the main biological parameters monitored in diabetes. The study took place throughout one year, of which the actual clinical study lasted 90 days, the rest of the time being spent to design the product and for the final tests. The study material was represented by 2 groups, a witness group of 30 patients and a study group of 35 patients. The study method consisted in the observation of some predetermined biological parameters at study entry, for each patient in the two groups.

KEYWORDS*: diabetes, bakery products, obesity, glycemia*

1. Introduction

According to the information from the World Health Organization (WHO), only in 2005 was estimated that 1.1 million deaths were caused by diabetes and this number is expected to double by 2030 [1,2]. In fact, the real number of deaths due to diabetes complications, especially renal and cardiovascular, is certainly much higher. Since it is believed there is a risk that diabetes will become a truly global epidemic, WHO together with the International Diabetes Federation develop programs of prevention and control of diabetes, that all countries must be aligned with. The strategy of diabetes prevention and management relates to diet, physical activity and anti-diabetic supplements, especially the natural ones. Promoting a healthy diet to combat obesity, together with moderate physical activity, is considered a determinant factor [3].

Food producers must also support patients with diabetes and people who want to eat as healthy

as possible. Making a type of bread for diabetics represents the solution of introducing into the diet an additional intake of fiber, together with other anti-diabetic components. The structure of the food ratio for diabetics is predominantly carbohydrate, but slow absorption carbohydrates and dietary fibers must have the highest share.

2. Material and methods

The study material consisted of two groups of patients:

-the witness group: 30 patients

-the study group: 35 patients

Study duration: 90 days.

The study method consisted in the observation of some predetermined biological parameters at study entry, for each patient in the two groups.

Study inclusion criteria:

- Patients diagnosed with diabetes;
- Patients diagnosed with diabetes, whether with or without obesity;
- Female patients diagnosed with gestational diabetes;
- Patients with diabetes induced by pancreatic or liver diseases: hepatic cirrhosis (not the postethanolic type), chronic pancreatitis, pancreatic cyst, pancreatic lithiasis.
- Possibility of a good collaboration;
- Patients without severe complications of the disease;
- Patients without immune deficiencies or serious associated diseases, which might influence the study results.

Exclusion criteria of patients diagnosed with diabetes:

- Patients with serious associated diseases: neoplasm, AIDS, tuberculosis under treatment;
- Patients with mental retardation;
- Patients with malnutrition-related diabetes;
- Patients with diabetes caused by disorders induced by drugs or chemical substances: alcoholism, narcotic dependents, etc;
- Patients with diabetes determined by certain endocrine diseases: Cushing’s syndrome, acromegaly, thyrotoxicosis, pheochromocytoma;
- Patients who withdrew from the study or did not cooperate in order to make the primary tests.

Follow-up protocol of patients: blood glucose tests will be done daily, pre- and postprandially, in both groups - a total of 6 blood glucose tests per day for each patient.

Medical tests for monitoring the patients included in the study, performed both at the beginning and at the end of the clinical study, in order to assess general health and evolution of diabetes and its possible complications, were: glycemia, glycosylated haemoglobin, total cholesterol, HDL cholesterol, triglycerides, GPT.

3. Results

At the beginning of the study, we have found the following statistical data of patients: *Group I (of study)*

Out of the 35 people who signed the collaboration agreement, only 27 (77%) actually participated in this study, the remaining 8 (23%) did not perform any tests and were excluded from the study. Out of the 27 patients who entered the study, 1 passed away (figure 1).

Of the withdrawn, 3 (37,5%) people were female and 5 male (62,5%).

Therefore, the actual study was conducted on a total of 26 people; statistical data presented below will refer only to those persons.

Patients' distribution according to age decades showed a preponderance of diabetes after the age of 50 (figure 2).

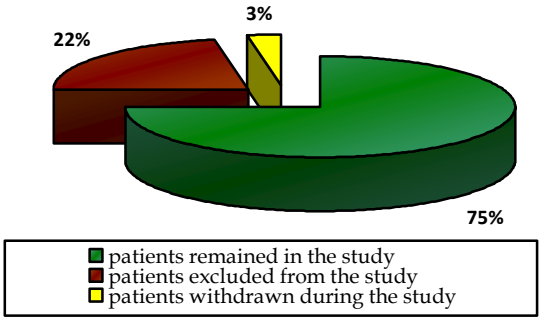

Figure 1. *Graphical representation of patients in group I who entered the study*

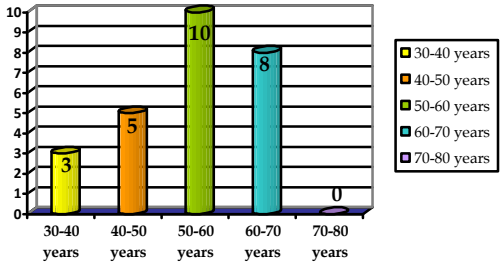

Figure 2. *Graphical representation by age groups of patients in group I who entered the study*

At the beginning of the study, the 6 parameters monitored throughout the entire study were measured, their values being represented in figure 3.

The average age of the group was 53.46 years, divided by gender – the average age for males was 47.12 years, and for females 56.27 years.

Gender distribution was 8 men (31%) and 18 women (69%).

The patients’ origin was 100% from urban areas, due to the fact that they have been conditioned by the possibility of taking 3 times a week the bakery product from the working points located in the city of Galati. (table I)

Table I. *Results of biological parameters observed for patients in group I at study entry*

GLYCEMIA	GLYCOSYLATED HAEMOGLOBIN	CHOLESTEROL	HDL CHOLESTEROL	TRIGLYCERIDES	GPT
121.00	7.76	149.00	38.50	111.	49.50
149.00	6.64	189.00	50.50	91.	34.80
115.00	7.04	297.00	42.00	542.	61.90
62.00	8.54	158.00	75.90	51.	14.80
237.00	7.87	222.00	57.60	183.	36.00
103.00	6.20	130.00	56.40	214.	35.10
65.00	6.10	254.20	73.00	173.	28.00
101.00	7.20	193.60	54.00	111.	38.00
318.00	11.00	236.00	74.80	105.	113.50
113.00	6.78	249.00	61.40	153.	20.60
119.00	8.20	269.72	41.18	238.	13.77
129.00	6.60	311.70	61.00	424.	20.00
216.00	8.27	175.00	56.80	121.	40.00
198.00	7.40	219.20	55.00	241.	12.00
228.00	9.90	257.00	59.00	224.	55.00
189.00	7.08	238.00	59.50	142.	23.10
111.00	6.20	252.00	61.40	193.	29.00
175.00	7.26	212.00	42.20	140.	58.90
142.00	6.78	214.00	46.80	117.	37.00
262.00	6.30	267.00	64.50	218.	47.20
143.00	6.60	176.00	30.10	303.	28.20
190.00	6.17	211.00	89.20	60.	61.20
177.00	6.40	162.00	78.00	40.	18.00
109.00	6.90	162.00	67.00	213.	33.00
203.00	7.37	188.00	69.30	134.	43.60
81.00	5.65	204.00	74.00	99.	71.00

The data obtained were statistically interpreted, the statistical graphic representation being reproduced in figure 3.

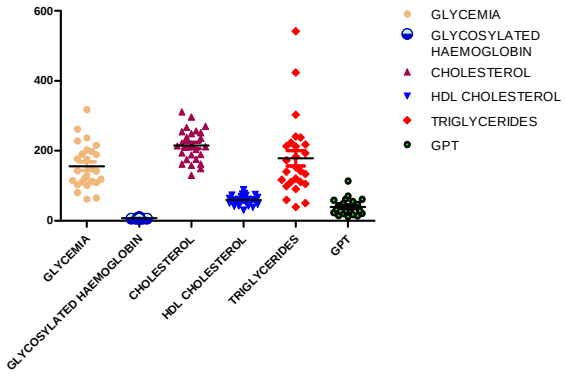

Figure 3. *Graphical representation of biological parameters observed for patients in group I at study entry (ANOVA test)*

Group II (witness)

Out of the 30 people who signed the collaboration agreement, only 24 (80%) actually participated in this study, the remaining 6 (20%) did not perform any tests and were excluded from the study. Out of the 24 patients who entered the study, for 4 persons tests were performed either only at the beginning of the study or at the end of it (figure 4).

Of the 6 persons excluded from the study, 4 (66,6%) were female and 2 male (33,4%).

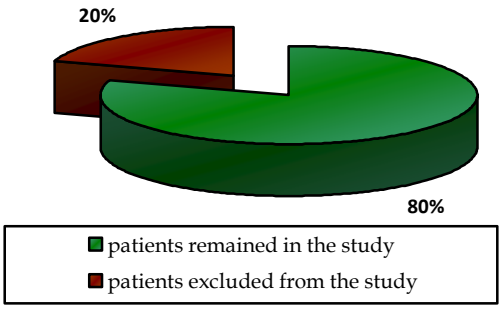

Figure 4. *Graphical representation of patients in group II who entered the study*

Therefore, the actual study was conducted on a total of 24 people; statistical data presented below will refer only to those persons.

Patients' distribution according to age decades showed a preponderance of diabetes after the age of 50 (figure 6).

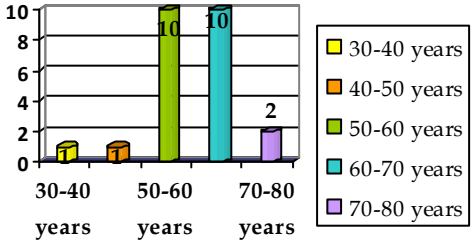

Figure 5. *Graphical representation by age groups of patients in group II who entered the study*

The average age of the group was 59.5 years, divided by gender – the average age for males was 58.12 years, and for females 60.18 years.

Gender distribution was 8 men (33.4%) and 16 women (66.6%).

The patients' origin was 100% from urban areas, due to the fact that they have been conditioned by the possibility of taking 3 times a week the bakery product from the working points located in the city of Galati.

For patients in group II of study, we proceeded in the same manner as for the previous ones, by measuring the proposed biological parameters at the beginning of the study (table II, figure 5).

Although they have signed the collaboration agreement, some of these patients were not present for sample collection, or tests have been only partially performed. However, the same samples were collected, being represented in the graphic with the symbol "*". Further this symbol signifies the absence of values for these tests.

Afterwards, the data obtained from these patients were also statistically analyzed, their graphic representation being described in figure 6 .

Table II. *Results of biological parameters observed for patients in group II at study entry*

	GLYCEMIA	GLYCOSYLATED HAEMOGLOBIN	CHOLESTEROL	HDL CHOLESTEROL	TRIGLYCERIDES	GPT
1	150.00	7.07	175.00	55.40	155.	27.00
2	123.00	6.88	167.00	46.10	115.	22.80
3	*	*	*	*	*	*
4	189.00	6.65	154.00	39.50	143.	30.10
5	*	*	*	*	*	*
6	178.00	7.05	200.00	49.80	119.	59.00
7	203.00	7.66	201.00	38.20	143.	35.60
8	284.00	7.49	213.00	60.90	145.	19.10
9	166.00	6.66	235.00	39.50	169.	34.40
10	141.00	7.76	149.00	58.10	111.	29.50
11	104.00	7.90	194.00	52.00	60.	25.00
12	117.00	6.17	204.00	45.50	172.	40.10
13	112.00	5.81	136.00	47.80	57.	26.70
14	115.00	9.10	144.00	57.40	98.	27.00
15	78.00	5.12	156.00	49.00	77.	31.80
16	153.00	6.76	211.00	52.80	72.	24.80
17	119.00	6.91	258.00	71.80	113.	14.50
18	160.00	7.90	120.00	33.70	112.	35.00
19	176.00	6.80	220.00	44.00	496.	149.00
20	162.00	6.95	194.00	29.70	351.	17.20
21	*	*	*	*	*	*
22	133.00	6.27	175.00	56.40	166.	35.00
23	113.00	6.68	249.00	51.40	156.	23.60
24	223.00	8.07	139.00	*	216.	23.00

Table III. *Results of biological parameters observed for patients in group I at the end of the study*

	GLYCEMIA	GLYCOSYLATED HAEMOGLOBIN	CHOLESTEROL	HDL CHOLESTEROL	TRIGLYCERIDES	GPT
1	87.00	8.84	123.0	32.10	102.	34.00
2	224.00	7.39	208.0	45.70	132.	40.00
3	107.00	7.34	207.0	47.10	271.	56.40
4	165.00	9.14	180.0	82.20	49.	12.20
5	165.00	7.63	243.0	56.80	176.	23.70
6	97.00	5.96	128.0	53.10	179.	20.80
7	113.00	6.60	197.5	56.00	175.	21.00
8	98.00	6.25	272.0	60.00	105.	29.10
9	306.00	10.52	250.0	76.30	101.	74.20
10	119.00	7.00	369.0	58.80	115.	15.70
11	212.00	9.41	372.0	49.20	243.	16.40
12	142.00	7.00	308.0	45.00	448.	19.00
13	133.00	9.00	185.6	52.00	160.	75.00
14	136.00	7.20	*	*	*	15.00
15	184.00	8.80	256.0	*	227.	54.00
16	129.00	6.40	198.0	59.80	122.	38.00
17	106.00	6.27	270.0	73.80	9.	24.60
18	199.00	7.93	258.0	38.60	186.	*
19	98.00	7.08	204.0	44.70	138.	26.50
20	211.00	6.40	206.0	65.60	212.	37.00
21	183.00	7.72	219.0	26.80	405.	19.80
22	212.00	7.59	232.0	76.20	63.	25.00
23	50.00	7.31	173.0	78.20	44.	19.10
24	136.00	6.42	172.0	53.00	206.	38.50
25	175.00	6.70	168.0	65.10	174.	33.70
26	99.00	5.55	210.0	67.60	166.	76.80

Table IV. *Results of biological parameters observed for patients in group II at the end of the study*

	GLYCEMIA	GLYCOSYLATED HAEMOGLOBIN	CHOLESTEROL	HDL CHOLESTEROL	TRIGLYCERIDES	GPT
1	143.00	8.36	182.00	52.70	93.00	14.00
2	143.00	7.19	187.00	48.10	118.00	18.50
3	185.00	7.40	217.00	35.00	239.00	31.00
4	263.00	8.36	152.00	42.10	112.00	29.90
5	104.00	7.00	154.00	34.00	73.00	40.00
6	201.00	7.15	146.00	46.80	90.00	*
7	315.52	8.65	210.94		236.09	*
8	142.00	6.64	266.00	88.30	87.00	23.90
9	167.00	6.96	218.00	53.10	179.00	28.00
10	198.00	8.81	189.00	68.40	78.00	13.40
11	*	*	*	*	*	*
12	110.00	6.70	231.00	42.40	*	*
13	136.00	6.19	201.00	52.20	49.00	34.20
14	104.00	9.52	124.00	45.70	103.00	13.40
15	152.00	5.81	198.00	56.40	120.00	29.30
16	129.00	7.08	198.00	44.70	88.00	27.00
17	134.00	8.01	218.00	56.90	264.00	18.50
18	167.00	6.40	127.00	30.00	152.00	40.00
19	142.00	6.91	254.00	48.90	432.00	161.30
20	*	*	*	*	*	*
21	138.00	7.10	168.00	62.00	129.00	24.00
22	131.00	6.81	178.00	46.40	181.00	17.50
23	125.00	6.65	250.00	43.70	292.00	28.70
24	251.00	8.31	156.00	46.40	244.00	24.30

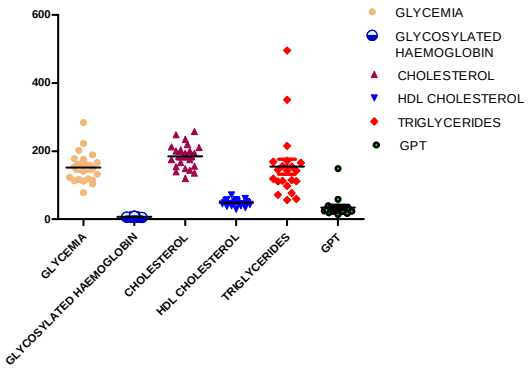

Figure 6. *Graphical representation of biological parameters observed for patients in group II at study entry (ANOVA test)*

At the end of the study, we have found the following statistical data of patients (p 0,0001) (table III).

For group I:

At the end of the study, data obtained from monitoring the 6 parameters proposed were once again statistically analyzed, being statistically represented in figure 7.

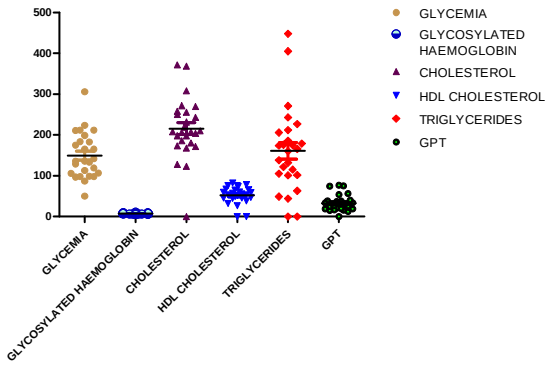

Figure 7. *Graphical representation of biological parameters observed for patients in group I at the end of the study (ANOVA test)*

For group II (figure 7, table IV)

The same statistical analysis was also performed for patients in group II; the data obtained was statistically processed, their graphic representation being shown in figure 8.

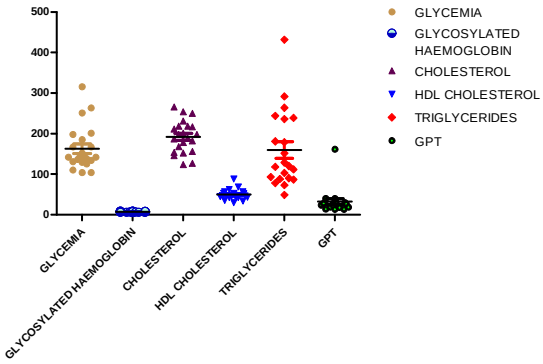

Figure 8. *Graphical representation of biological parameters observed for patients in group II at the end of the study (ANOVA test)*

4. Discussions

Diet is of paramount importance in the treatment of diabetes, being the best means of balancing the disease. Not only does it help balance glycemia, but it also contributes to avoiding diabetes complications - hypoglycemia or hyperglycemia and, on a long term, it reduces the risk of renal, neurological or cardiovascular diseases. The diet of a diabetic should include enough calories to maintain a healthy weight, to ensure normal growth in children and adolescents and to meet additional needs in case of physical activity, pregnancy, lactation or illness. The purpose of the diet is to ensure an adequate intake of nutrients, both qualitative and quantitative. Therefore, nutrition must be regular (avoiding variability in insulin requirements) and fragmented (usually, three lunches and two snacks). Nowadays, diabetics are recommended a diet as close as possible to a balanced nutrition (but the carbohydrate content is weighed and calculated).

The effects of these products are expected to provide patients with diabetes the possibility of eating bakery products too, without significantly influencing their glucose levels and putting their health at risk, just like other products for this category of patients. At the same time, we hope to achieve an improvement of these patients’ living comfort and psychological status, as well as of their dyslipidemia disorders.

The proposed objectives were as follows:

- Keeping glycemia levels as close as possible to the normal limits;
- Prevention of diabetes complications (diabetic retinopathy, diabetic neuropathy);
- Prevention of obesity and keeping it under control;
- Prevention of diabetes in some pancreatic diseases, such as pancreatitis;
- Prevention of diabetes in pregnancy;
- Improving and maintaining the best possible rates of biological parameters of the lipid metabolism;
- As a means of prevention of obesity and diabetes in healthy and apparently healthy people;
- To allow patients with diabetes relatively normal consumption of bakery products (bread); this would lead to the elimination or at least significant mitigation of the psychological complex induced by diabetes, namely that this is a more or less “disabling” disease, with influence on patients’ social life.

In order to establish the manufacturing formula of the product that was going to be used in the clinical study, 4 samples of bread were made, They were analyzed in the Laboratory of Physico-Chemical and Microbiological Analysis of Food (accredited by RENAR), part of the Food Industry and Aquaculture Biotechnologies Research Centre within the Faculty of Food Science and Engineering. All tests were made in triplicate and the results represent the average of the three determinations. Apart from the common physico-chemical and microbiological tests, the samples were also analyzed in terms of the carbohydrate composition of the fibers, the content of vitamins B1, B2 and B6, the antioxidant activity and the content of total phenolic compounds.

B-group vitamins are involved in converting carbohydrates into energy, as well as in the lipid and protein metabolism. Vitamins B1, B2 and B3 are particularly useful in prevention and management of diabetes.

Vitamin B1 plays a central role in the carbohydrate metabolism and, in case of high intake of carbohydrates in the diet, it increases the need for thiamine. TPP (thiamine pyrophosphate) is an enzyme cofactor essential for the enzymes involved in the carbohydrate catabolism. but also in that of amino acids. Thiamine is a cofactor for the pyruvate dehydrogenase and the alpha-ketoglutarate dehydrogenase, enzymes involved in the glucose flux through glycolysis coupled with the Krebs cycle.

Deficiency induces neurological disorders and disorders of the cardiovascular system, fatigue, loss of appetite, weight loss, etc. Patients with diabetes frequently have a more or less severe thiamine deficiency, associated with some complications of the disease, especially with the renal ones. Induced diabetes has been associated with the vitamin B1 deficiency, characterized by a significant decrease in the plasma thiamine concentration and in the activity and expression of the transketolase from the glomerular tissue. Patients with type 1 and 2 diabetes show a similar decrease in the plasma thiamine level [4,5].

Vitamin B2 is essential in many cellular processes, playing a key role in the metabolism of carbohydrates, lipids, ketone bodies and proteins. Moreover, it is involved in the hemoglobin synthesis, the process of sight and growth of young organisms. Even since 1986, experiments on laboratory animals with induced diabetes have proved that the disease dramatically reduces the activity of three FAD-dependent enzymes: erythrocyte glutathione reductase, hepatic glutathione reductase and hepatic succinate dehydrogenase. The activity of all enzymes was normalized after administration of insulin or riboflavin. Studies conducted on rats have shown that experimental diabetes induces riboflavin deficiency, which leads to reduced activity of the hepatic flavin and erythrocyte enzymes [6]. Several other more recent studies support that Vitamin B2 is directly involved in the management of insulin-dependent diabetes [7,8,9,10]. Nevertheless, the pathogenesis of riboflavin deficiency in patients with diabetes is not fully elucidated.

Niacin plays an important role acting as coenzyme involved in the energy metabolism, the amino acid metabolism and the detoxification reactions. Several studies have shown the involvement of nicotinic acid in lowering LDL cholesterol level. Moreover, it seems that increased intake of niacin, in the form of nicotinamide, improves beta cell regeneration in cell cultures and has protective action against residual insulin secretion, in patients with insulin-dependent diabetes, Therefore, niacin is involved in diabetes management [11,12,13]. Its heart-health benefits are listed on the American Heart Association website (http://www.heart.org/) and are motivated by serious and extensive studies in specialized magazines hosted by the association [14].

5. Conclusions

The newly obtained bakery product definitely favors the digestion of food and significantly improves the intestinal transit. This fact was confirmed by most of the patients included in this study, even by those who had had chronic constipation for years, who mentioned they had noticed a constant and significant improvement in the intestinal transit.

As compared with normal bread consumption, the patients said they could eat this bread normally, with no restriction (150 g/day), without any hypo- or hyperglycemic episodes.

Throughout this study, the patients noted they have not gained more than 1-2 kg, taking into consideration the fact that the study overlapped with the winter holidays.

The percentage of those excluded from the two groups, 25% for group I and 20% for group II, is a significant one, since they expressed their interest and willingness of cooperation in this study and consented in writing.

Distribution by age decades, both of patients in group I and in group II, showed a preponderance of diabetes after the age of 50, with an average age of 53.46 years for group I and 59.5 years for group II.

The global statistical study of the 6 biological parameters observed in group I, at the beginning of the study, showed p <0.0001, Friedman index of 109.3, Bartlett's index = 276.5, noting that all values of the six biological parameters were measured.

The global statistical study of the 6 biological parameters observed in group I, at the end of the study, showed p <0.0001, Friedman index of 97.73, Bartlett's index = 255.5, noting that only 153 out of 156 values of the six biological parameters were measured.

The global statistical study of the 6 biological parameters observed in group II, at the beginning of the study, showed p <0.0001, Bartlett's index = 225.5, noting that 125 out of 144 values of the six biological parameters were measured.

The global statistical study of the 6 biological parameters observed in group II, at the end of the study, showed p <0.0001, Friedman index of 97.73, Bartlett's index = 211.2, noting that only 127 out of 144 values of the six biological parameters were measured.

As a general conclusion, all parameters observed in this study had a much more favorable evolution for patients in group I, who consumed these bakery products. Their values substantially decreased at the end of the study, except for the cholesterol levels. We must however mention the fact that this study overlapped with the winter holidays, during which it is known that pork is predominantly consumed.

There is a remark that we want to make regarding this study: the values of parameters observed in this study may change due to the daily diet. Even though all patients received instructions regarding the type of diet, we had no way to control this; moreover, many of them mentioned that they had food excess on the occasion of the winter holidays. We consider that, provided we could have properly monitored the diet and medication of all patients in the two groups, the results could have been more favorable for patients in group I. However, in order to do this, hospitalization of all these patients would have been required, which was actually impossible.

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References

1. **AHA Journals** – www.ahajournals.org;
2. American Heart Association Web site – http://www.heart.org;
3. **M.T. Johnstone şi A.Veves,** Diabetes and cardiovascular disease. Second Edition, Humana Press, 2005;
4. **N. Rabbani. ş.a.,** High-dose thiamine therapy for patients with type 2 diabetes and microalbuminuria: a randomised, double-blind placebo-controlled pilot study, Diabetologia, 2009; 52 (2): 208-212;
5. **J.A. Maassen, ş.a.,** Mitochondrial Diabetes. Molecular Mechanisms and Clinical Presentation, Diabetes, 2004; 53 (S1): S103-S109;
6. **A.S. Reddi,** Riboflavin nutritional status and flavoprotein enzymes in streptozotocin-diabetic rats, BBA, 1986; 882 (1): 71-76;
7. **A. Arnoldi**, Functional foods, cardiovascular disease, and diabetes, CRC Press, 2004;
8. **N. Apelt, ş.a.,** ACP1 genotype, glutathione reductase activity, and riboflavin uptake affect cardiovascular risk in the obese, Metabolism. Clinical and Experimental, 2009; 58 (10): 1415-1423;
9. **A.V. Lakshmi,** Riboflavin metabolism--relevance to human nutrition, Indian J. Med. Res., 1998; (108): 182-190;
10. **A. Nissenkorn,** Multiple presentation of mitochondrial disorders, Arch. Dis. Child, 1999; (81): 209-214
11. **Cervantes-Laurean,** Modern Nutrition *in* Health and Disease, ed. by Shils M. E., Olson J. A., Shike M., Ross, A.C., Baltimore, Williams & Wilkins, 1999, pg. 401-411;
12. **M.B. Elam**, Effect of Niacin on Lipid and Lipoprotein Levels and Glycemic Control in Patients With Diabetes and Peripheral Arterial Disease, The ADMIT Study: A Randomized Trial, JAMA, 2000; 284 (10): 1263-1270;
13. **M. Navab,** HDL as a Biomarker, Potential Therapeutic Target, and Therapy, Diabetes, 2009; 58 (12): 2711-2717;
14. **B.J. Wu,** Evidence That Niacin Inhibits Acute Vascular Inflammation and Improves Endothelial Dysfunction Independent of Changes in Plasma Lipids, Arterioscler. Thromb. Vasc. Biol., 2010; (30): 968 – 975;