

A comparison of blood glucose and insulin responses in subjects with non-insulin dependent diabetes mellitus consuming potato alone, and potato with sunflower oil

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Abstract

Aim: The objective of this study was to compare between carbohydrate intake and carbohydrate with sunflower oil intake effects on blood glucose and insulin levels for using to plan the diets for type II diabetes mellitus.

Material and method: In our study, two types of test foods were given to 10 voluntary type II diabetic patients (4 male, 6 female, mean age 50.3 ± 14.6 years and mean duration of diabetes 3.1 ± 0.3 years), and fasting and postprandial blood sugar and insulin parameters were examined and compared.

As the 1st test meal: 250 grams of potato (containing 50 grams of carbohydrate) were boiled for 45 minutes, then fed to the subjects.

As a 2nd test meal: after 14 days from the 1st test meal, 250 grams of potato were boiled for 45 minutes, peeled and fed in puree form with the addition of 20 ml sunflower oil.

Blood samples were taken before and 30, 60, 90 and 120 minutes after the test meals, respectively.

Results: When the serum glucose and insulin levels in blood samples from patients were examined, the relationship between potato alone and potato with sunflower oil co-administration was not statistically significant ($p > 0.05$, for all times)

Similarly, there was no difference in glucose areas after the 1st and 2nd test meals ($p = 0.562$, $p > 0.05$). There was also no significant difference in the serum insulin area after the 1st and 2nd test meals ($p = 0.90$, $p > 0.05$).

Conclusion: There is not a difference in terms of serum glucose and insulin responses in the type II diabetic patients when they are only fed boiled potatoes, a food with high glycaemic index, compared to when the boiled potato is added 20 ml of sunflower oil. As can be understood from this study, when regulating the diet of the type II diabetic patients, it should be planned considering the glycaemic index of the food given as it is, since adding fat to the food does not affect the serum glucose and insulin response.

Keywords: Carbohydrate, Potato, Fat, Blood Glucose, Blood Insulin, Glucose Response, Insulin Response, Type II Diabetes

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1. Introduction

Diabetes mellitus is considered to be a condition that develops as an absolute or relative insulin deficiency and its most prominent feature is hyperglycaemia, which can lead to significant changes in lipid metabolism [Jarret, 1976]. When diabetes is considered as a whole, it constitutes the primary cause of blindness in some countries, and the cause of 75% of lower limb amputations. One of the most important complications of diabetes is vascular complications, which in conjunction with carbohydrate metabolism facilitates the formation of anomalous vascular dysfunction in lipid metabolism [Bağrıaçık, 1988]. In this study of Type II DM, which is one of the major problems in the world, blood glucose and insulin responses have been investigated in patients with Type II DM, against ingestion of potato alone and potato ingestion with oil.

Carbohydrates in foods are generally divided into two groups as simple (sugar) or compound (starch). Simple carbohydrates, which are often used in foods, raise blood glucose levels more and more rapidly than complex carbohydrates in starchy foods. It is much bigger than the response of all foods containing 50 g starch [Anderson, 1994]. Jenkins et al. [1994] use the term glycaemic index to compare the glycaemic response to a reference food such as white bread or glucose with the glycaemic response to test food containing the same amount of carbohydrates [Anderson, 1994].

It is not possible to predict what kind of physiological response will result by looking at the chemical composition of a food, since many factors in the foods can affect digestive and absorption rates and glycaemic responses of these foods, many of these factors are not included in the food lists and most of them are not related to the foods content. Therefore, in order to predict the physiological effects of foods, the "glycaemic index", which has been tested with chemical compounds, should also be reported. It is thought that this information will help to better understand the effects of carbohydrate foods and to select appropriate foods for treatment diets. Glycaemic index values may differ according to the method of calculation and other methodological variables [Anderson, 1994; Jenkins, 1994]. Glycaemic index value shows the ratio and rate of digestion and absorption of different starchy foods [Jenkins, 1995].

In many studies, the response variability to carbohydrates in certain foods has been determined to be due to their characteristics that may look minor (such as processing rice grain, variety of potato, ripeness of banana) [Anderson, 1994; Jenkins, 1994].

Different people may have different glycaemic responses to the same food according to their glucose tolerance. Glycaemic indexes of the same foods are the same in normal and diabetic individuals [Anderson, 1994]. It is not right to determine the glycaemic index of foods with a single test because blood glucose response in individuals changes from day to day. Glycaemic index can also be used in mixed meals if appropriate methods are used. The glycaemic index of a meal is the weighted average of the glycaemic index values of all carbohydrate foods at that meal. When taking the weighted average rate, the contribution of each food to the total carbohydrate at that meal is taken as proportioned [Jenkins, 1994].

The way the food is cooked and the carbohydrates contained in the various ingredients involved affect the glycaemic index. Potato is one of the foods often added to oil, and it can affect the glycaemic index, especially by changing the gastric emptying. We also aimed to investigate the effects of adding oil to potato, which has the most common glycaemic index in our study and is widely used by the public because of its cheap price and practical usage, to plasma glucose levels and to insulin response.

2. Material and method

Patients with Type II diabetes mellitus (untreated, at the diet arrangement stage, given no antidiabetic) were taken to study. The age, gender, and diabetes age of the patients are shown in Table I.

Table 1 The age, gender and diabetes age of patients

Subject number	Sex	Age (year)	Diabetes Age (year)
1	M	50	3
2	M	70	2
3	M	27	0,66
4	F	60	4
5	F	37	3
6	F	33	0,92
7	F	65	5
8	F	64	7
9	F	51	2
10	M	46	3
General Assessment	6F/4M	50.3 ± 14.62	3.1 ± 0.31

-1st Test Food: Potatoes (250 grams) containing 50 grams of carbohydrates were boiled for 45 minutes, peeled and prepared in pieces.
 -2nd Test Food: Potatoes (250 grams) containing 50 grams of carbohydrates were boiled for 45 minutes, peeled, mashed with a spoon. This puree was mixed well with 20ml sunflower oil.

-1st test meal (when people were taking at least 200 grams of carbohydrate per day on their usual diet) was fed within 15 minutes after a night's fasting.
 -2nd test meal was fed 14 days after the first test meal (when people were taking at least 200 grams of carbohydrate per day on their usual diet).

Blood samples were taken before the test meals and 30, 60, 90 and 120 minutes after the meals. In those samples, serum glucose was determined. Serum samples were stored in deep freeze for insulin determinations. Glucose determinations were made by the glucose 6 phosphate dehydrogenase hexokinase (G6PDH) method using Abott commercial kits. Insulin determinations were performed by the RIA method using Coat-a-Count insulin kits from DPC.

The average age of the patients was 50.3 ± 14.62 years and the average age of diabetes mellitus was 3.1 ± 0.31 years, with 4 male (40%) and 6 female patients (60%). Glucose and insulin areas were calculated based on the following formula [Gannon, 1990; Jenkins, 1994].

Student-t test was used for matched sequences and the significance limit was accepted as $p < 0.05$.

3. Results and Discussion

3.1. Results

Average serum glucose levels and serum insulin levels of the participants before the 1st test meal and at the 30th, 60th, 90th and 120th minutes after the 1st test meal are provided (Table 2 and 3, Figures 1 and 2).

Average serum glucose levels and serum insulin levels before the 2nd test meal and at the 30th, 60th, 90th and 120th minutes after the 2nd test meal are provided (Table 2 and 3, Figures 1 and 2).

Table 2 – The average Serum Glucose responses to the 1st meal and 2nd meal (mg/dl) and P values

	Fasting	30th minute	60th minute	90th minute	120th minute
1st meal	121.77 ± 31.28	157.39 ± 43.09	177.44 ± 67.87	157.27 ± 69.32	148 ± 55.99
2nd meal	130.52 ± 36.05	159.61 ± 46.57	185.99 ± 58.29	181.23 ± 61.12	163.23 ± 52.07
P values	0.569	0.913	0.765	0.423	0.536

Figure 1 – The average Serum Glucose responses to the 1st meal and 2nd meal (mg/dl)

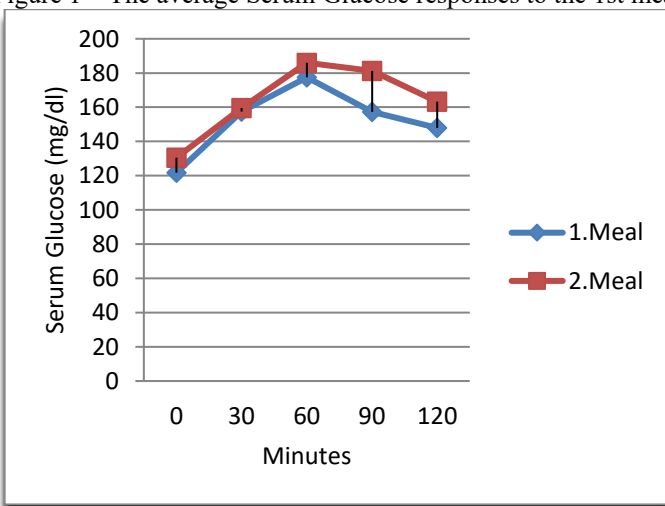
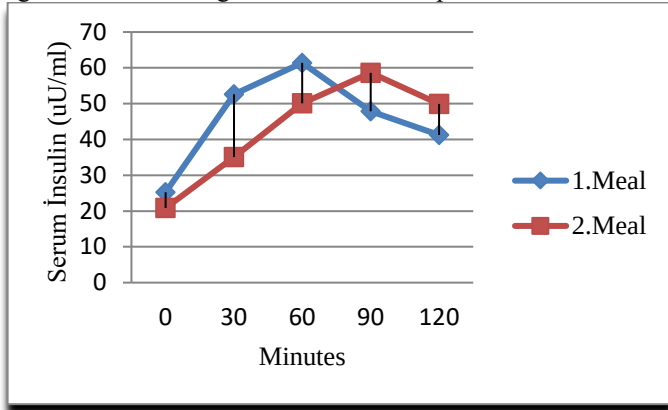


Table 3 – The average Serum Insulin responses to the 1st meal and 2nd meal (uU/ml) and P values (Supplementary Files Table 3)

	Fasting	30th minute	60th minute	90th minute	120th minute
1st meal	25.24 ± 7.42	52.60 ± 20.40	61.40 ± 28.94	47.88 ± 24.36	41.27 ± 19.28
2nd meal	20.85 ± 8.38	35.05 ± 19.18	50.10 ± 20.04	58.62 ± 26.05	49.90 ± 19.72
P values	0.231	0.06	0.323	0.353	0.339

Figure 2 – The average Serum Insulin responses to the 1st meal and 2nd meal (uU/ml)



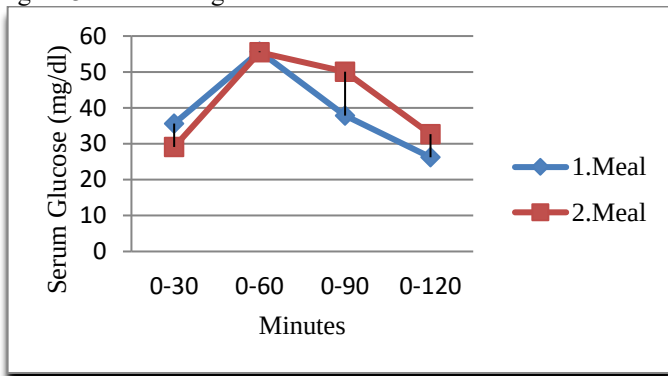
As seen in Table 2 and Table 3, the p values were not significant for the averages of the glucose and insulin values at all times after 1st and 2nd meals ($p > 0.05$). The average values of the serum glucose responses to the 2nd meals were 0.569 at fasting; 0.913 at the 30th minute; 0.765 at the 60th minute; 0.423 at the 90th minute and 0.536 at the 120th minute. The p values obtained from the average of serum insulin responses to the 2nd meals were 0.231 for fasting, 0.06 at 30th minute; 0.323 at 60th minute; 0.353 for the 90th minute and 0.339 for the 120th minute. The average values (mg/dl) of the serum glucose responses to the 1st and 2nd meals are shown in Figure 1 and the average values (uU/ml) of the serum insulin responses to the 1st and 2nd meals are shown in Figure 2.

The average values of the serum glucose elevations and the p values of the cases in response to the 1st and 2nd meals are given in Table 4. It is seen in Figure 3. As can be seen, the p values are not significant ($p > 0.05$).

Table 4 - The average values of the Serum Glucose elevations response to the 1st and 2nd meal (mg/dl) and P values (Supplementary Files Table 4)

	0-30 Minutes	0-60 Minutes	0-90 Minutes	0-120 Minutes
1st meal	35.62 ± 17.28	55.72 ± 39.70	37.82 ± 37.66	26.24 ± 27.09
2nd meal	29.09 ± 16.28	55.47 ± 26.47	50.71 ± 32.15	32.71 ± 24.39
P values	0.396	0.986	0.421	0.581

Figure 3 - The average values of the Serum Glucose elevations response to the 1st and 2nd meal (mg/dl) (Supplementary Files Figure3)



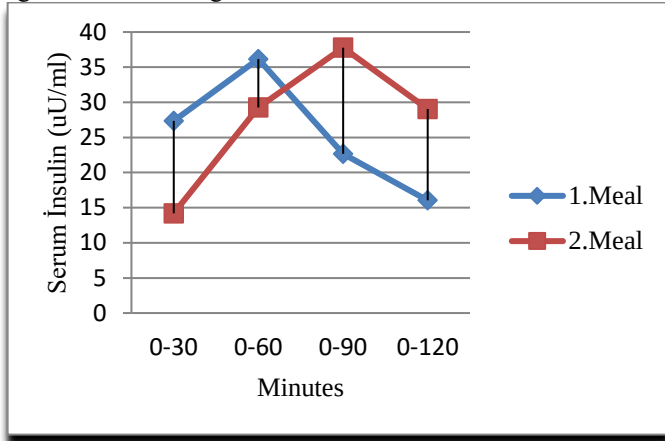
Also, the averages and the p values of the elevations in the serum insulin responses of the cases to the 1st and 2nd test meals are given in Table 5. The p values were determined as 0,073 for 0-30 minutes; 0,469 for 0-60 minutes; 0,114 for 0-90 minutes and 0,068 for 0-120 minutes.

As can be seen, the p values are not significant ($p > 0.05$). Figure 4 shows the average serum insulin elevations.

Table 5 - The average values of the Serum Insulin elevations response to the 1st and 2nd meal (uU/ml) and P values (Supplementary Files Table 5)

	0-30 Minutes	0-60 Minutes	0-90 Minutes	0-120 Minutes
1st meal	27.36 ± 17.36	36.16 ± 25.26	22.64 ± 18.63	16.03 ± 13.68
2nd meal	14.20 ± 13.37	29.25 ± 15.31	37.77 ± 21.99	29.05 ± 16.30
P values	0.073	0.469	0.114	0.068

Figure 4 - The average values of the Serum Insulin elevations response to the 1st and 2nd meals (uU/ml) (Supplementary Files Figure4)



The average values of the serum glucose responses (mg/dL) of the female subjects to the first and second meals and the average glucose responses (mg/dL) of the female subjects to the first test meal were 113.21 ± 29.01 for fasting; 146.26 ± 37.16 at the 30th minute; 145.48 ± 37.67 at 60th minute; 137.58 ± 59.43 at 90th minute and 129.43 ± 45.61 at the 120th minute.

The average glucose response (mg/dL) to the second test meal for the female subjects was 121.13 ± 32.66 at fasting, 152.20 ± 44.49 at the 30th minute; 174.38 ± 57.49 at the 60th minute; 131.56 ± 60.73 at the 90th minute; and at the 120th minute it was 151.55 ± 50.09 . The p values were 0.666 (fasted); 0.807 (30 min); 0.327 (60 min); 0.865 (90 min); 120 min. and 0.442. These values were not found statistically significant ($p > 0.05$).

The averages of the serum insulin responses of the female subjects to the first and second test meals were: the average serum insulin values after the first test meal (u/mL) were 25, 38, 31 at fasting; 57.83 ± 19.07 at the 30th minute; 66.83 ± 24.22 at the 60th minute; 50.36 ± 25.74 at the 90th minute and 38.23 ± 17.01 at the 120th minute. The average values of the insulin responses (uU/mL) of the female subjects to the second test meal were 21.61 $\pm$ 9.96 at the 0th min; 39.20 ± 18.12 at the 30th minute; 53.33 ± 11.39 at the 60th minute; 59.66 ± 15.18 at the 90th minute; and for the 120th minute, it was 51.16 ± 9.98 .

The p values were found 0.493 at the 0th minute; 0.113 at the 30th minute; 0.245 at the 60th minute; 0.463 at the 90th minute and 0.139 for the 120th minute. Based on this, p values were not found significant ($p > 0.05$).

The average values of glucose responses (mg/dL) given by the male subjects to the first test meal were 134.6 ± 34.44 for fasting; 174.07 ± 51.48 at the 30th minute; 160.37 ± 65.48 at the 60th minute; 186.8 ± 81.22 at the 90th minute and 175.85 ± 64.91 at the 120th minute. For the second test meal, the values (mg/dL) were 144.6 ± 40.99 for fasting, 170.72 ± 54.14 at the 30th minute, 203.4 ± 63.35 at the 60th minute; 184.95 ± 80.38 at the 90th minute; and for the 120th minute, it was 205.75 ± 29.91 . The p values were 0.721 (fasting); 0.931 (30th min); 0.381 (60th min); 0.975 (90th min); and 0.434 (120th min). Those values were not statistically significant ($p > 0.05$).

The average insulin responses of the male subjects to the 1st meal (uU/mL) were 27.52 ± 2.97 at the 0th minute; 44.95 ± 22.32 at the 30th minute; 53.25 ± 37.25 at the 60th minute; 44.15 ± 25.41 at the 90th minute; and 45.82 ± 21.94 at the 120th minute.

The average insulin responses (μ U/mL) of the male subjects to the second test meal were 19.7 ± 6.52 at the 0th minute; 28.85 ± 21.69 at the 30th minute; 45.25 ± 30.60 at the 60th minute; 47.05 ± 34.16 at the 90th minute; and 48 ± 31.50 at the 120th minute.

The p values were 0.071 (fasted); 0.340 (30th min); 0.751 (60th min); 0.896 (90th min); and 0.917 (120th min). These values were not statistically significant ($p > 0.05$).

The average serum glucose area (area under the glucose curve) (min/mg) in response to the 1st and 2nd test meals and the p values are shown in Table 6 in Figure 5.

The average serum glucose area (min/mg) was 3.24 ± 1.17 for the 1st test meal, while the average serum glucose area (min/mg) 3.54 ± 1.07 for the 2nd test meal. P value is 0.562, which is not significant ($p > 0.05$).

In Table 7, the averages of the serum insulin area (area under the insulin curve) (min uU) and the p value in response to the 1st and 2nd test meals are provided, which are shown in Figure 6.

The average insulin content for the 1st meal is 0.97 ± 0.39 . The p value is 0.900 and is not statistically significant ($p > 0.05$).

Table 6 - Serum Glucose Area (dk.mg) and P value (Supplementary Files Table 6)

1st meal	2nd meal	P value
3.24 ± 1.17	3.54 ± 1.07	0.562

Figure 5 - Serum Glucose Area (dk.mg) (Supplementary Files Figure 5)

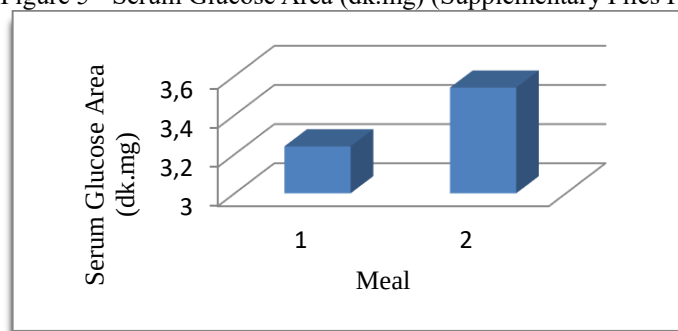
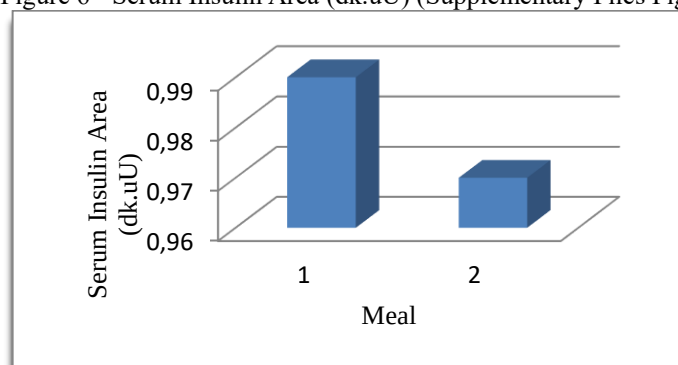


Table 7 - Serum Insulin Area (dk.uU) and P value (Supplementary Files Table 7)

1st meal	2nd meal	P value
0.99 ± 0.38	0.97 ± 0.39	0.9

Figure 6 - Serum Insulin Area (dk.uU) (Supplementary Files Figure 6)



3.2. Discussion

As a result of the epidemiological studies carried out, it is known that with the enrichment of nations, the structure of carbohydrates consumed by people has changed and the use of complex carbohydrates has decreased compared to simple carbohydrates. It is thought that this change in diets can lead to diseases such as atherosclerosis, diabetes and hyperlipidaemia [Gürçan, 1993]. In Type II diabetes, the CHO ratio in the diet is of great importance, and carbohydrate-restricted diets are recommended in treatment. A decrease in the CHO ratio of the diet is known to decrease the postprandial blood glucose and insulin levels. One of the aims of diabetic treatment is to prevent large changes in blood glucose levels that occur throughout the day [Behall, 1989]. Choosing carbohydrate foods that minimize the postprandial blood glucose changes is recommended for diabetic patients [Nelson, 1994; Nuttall, 1991; Wolever, 1986]. In studies conducted in this area, it has been shown that various foods containing carbohydrates produce very different glycaemic responses in diabetic patients [Anderson, 1994; Gürçan, 1993; Jenkins, 1995; Nelson, 1994]. Often, simple CHOs in foods raise blood glucose levels more than complex carbohydrates in starchy foods [Anderson, 1994]. Many researchers compared the glycaemic responses of foods rich in complex carbohydrates. In order to know the physiological effects of foods in advance, the concept of glycaemic index has been developed along with their chemical compounds. It has been thought that this information will help to better understand the effects of carbohydrate foods and to select appropriate foods for the treatment of diabetes [Jenkins, 1994].

Glycaemic index is defined as an index showing the relative ratio of postprandial blood glucose elevations to food intake. Glycaemic index values are used to classify foods according to their glycaemic effects [Anderson, 1994; Nishimune, 1991]. The positive effects of foods with low glycaemic index on blood glucose regulation are known [Brand, 1991; Jenkins, 1984a].

These positive effects can even be reflected in the next meal. In a study conducted in 1988, Wolever et al. [1988] found that the glycaemic response to morning breakfast was quite low when eating low-glycaemic index foods at dinner. There are many factors that affect the blood glucose level that occurs in response to the food ingested and cause differences in the calculation of GI values [Anderson, 1994; Jenkins, 1995; Mann, 1987].

These factors and their effects are:

1. The effect of carbohydrates: Nutrient carbohydrates have different absorption rates. Galactose and glucose are the fastest absorbed monosaccharides. These are followed by fructose, mannose, xylose and arabinose [Mayes, 1988]. The simple CHOs contained in foods are absorbed more rapidly than complex carbohydrates and lead to sudden increases in plasma glucose and insulin levels [Davidson, 1991; Jenkins, 1984b].
2. Effect of fibre content: Foods containing too much fibre are slowly digested, and in diabetic and non-diabetic individuals, they may cause a slight increase in satiety blood glucose and insulin levels. The slowing of the rate of gastric digestion of starch polysaccharides, the shortening of the duodenal passage of stomach contents and the upper passages of the small intestines and the slowing of the absorption rate of monosaccharides from the jejunum and upper ileal epithelial cells is considered to be the mechanism of hypoglycaemic action of dietary fibre [Blackburn, 1984; Sandhu, 1987; Schwartz, 1988; Wolever, 1990].
3. Effect of starch: Because the starch contained in foods cannot be digested at the same rate, it cannot increase the blood glucose level at the same rate either. Amylose and amylopectin ratio in starch is effective on digestion. Because it is very slowly hydrolysed by the intestinal enzymes, starchy foods containing too much amylose are reported to have a lowering effect on blood glucose levels [Gürçan, 1993; Jenkins, 1994].
4. Effects of protein and fat: Eating fat and protein along with carbohydrate foods can have a glycaemic response-reducing effect in non-diabetic and NIDDM individuals, by delaying the gastric emptying and increasing insulin secretion. However, in order for fat and protein to have significant effects, it may be necessary to ingest them in much more amounts than what is normally eaten or recommended on the diet [Nuttall, 1984; Wolever, 1991]. In a study conducted by Gannon et al. [1988], the addition of various proteins to glucose meal increased the area of glycaemia in type II diabetes.
5. Nutrient Inhibitors: Phytates, lectins, tannins, enzyme inhibitors, and saponins, which are nutrient inhibitors in foods, have a characteristic that affects digestibility and glycaemic response of starch in the gastrointestinal tract. Such inhibitors reduce the digestion rate of starch and allow the elevation of postprandial glycaemia to be at a lower rate [Jenkins, 1984a; Wolever, 1990]. Therefore, the use of these nutrient inhibitors may be effective in dietary therapy as well.
6. Quantity, shape and type of process applied to the food served: The GI value of a food can be determined using an amount of 50 g digestible CHO [Anderson, 1994; Jenkins, 1994; Jenkins, 1995]. The difference in the GI value of the examined food may be avoided by determining the actual portion size [Wolever, 1991]. Another factor that is effective in the digestion of carbohydrates is the physical condition of the food. Foods that are not grinded or shredded give lower GI values [Anderson, 1994; Gürçan, 1993; Jenkins, 1984b; Wolever, 1991]. The way the foods are cooked also has an effect on the glycaemic results. Cooking of starch facilitates digestion and absorption in the small intestine. This leads to increased blood glucose levels. This may be attributed to the deterioration of the structure of the starch granules and the increased sensitivity to amylase due to the cooking process. With less processed foods, lower glycaemic results can be obtained [Brand, 1985; Ross, 1987]. Crapo et al. [1977] have shown that rice and wheat bread have lower glycaemic effects than potatoes. This is attributed to the fact that the amount of amylose in the potato starch is less and therefore its digestion is faster.

Other factors affecting glycaemic index are physiological effects, including pregastric hydrolysis, gastric emptying rate, intestinal hydrolysis and absorption, pancreatic and gastric hormone responses, and colonic effects [Anderson, 1994; Jenkins, 1995]. The interactions of the different nutrients in the food play a role in the glycaemic index, or, with a broader definition, in the plasma glucose response to the food ingested [Gannon, 1993]. Essentially, food is often taken as a combination of several kinds of nutrients [Gannon, 1988]. Potato is an important CHO source and is one of the foods with the highest glycaemic index. It is usually ingested with oil, and how adding oil to potato affects the glycaemic index of potato is an important issue. We also did this work to see the glycaemic response that takes place when potato is ingested with oil. In our study, we boiled 250 grams of potatoes (equal to 50 grams of CHO) for 45 minutes, then peeled off the skin and fed to 10 patients with type II diabetes. Then again, after a period of 1-2 weeks, we added 20 ml sunflower oil (rich in unsaturated fatty acids) to the same type and amount of potatoes, and fed them to the same individuals.

Comparison of values after the 1st and 2nd test meals showed that the amount of fat we added did not affect the glycaemic response and there was no significant difference between the time when we gave potatoes alone and the time we gave potatoes + 20 ml sunflower oil. Similarly, there was no significant difference in glucose levels after the 1st and 2nd test meals (Figure 5).

In another study that could be paralleled with this study, it was shown that 5,15,30,50 gr of butter added to the potatoes did not affect the glycaemic field in the normal individuals and the type II diabetics, however, increased the insulin area. The increase in insulinemia is thought to be due to a reduction in hepatic clearance rather than an increase in insulin secretion [Gannon, 1993].

In our study, there was no significant difference in insulin responses between the two test diets in terms of both time and insulin area (Figure 6). However, in a study by Collier et al. [1983], it has been shown that adding oil (butter) to carbohydrates significantly reduces the glycaemic response as well as the insulin response. Researchers have attributed these findings to the delayed gastric emptying by fat. Indeed, experimental studies have shown that fat slows gastric emptying [Gannon, 1988; Waugh, 1936]. Flatt et al. [1985] reported that the presence of 50 gr mid-chain fats in the diet alleviated the elevation of glucose, while adding margarine did not

have the same effect. They attributed this to the fact that instead of coming together with the chylomicrons and being transported by ductus thoracicus, medium-chain fatty acids bind to albumin and directly go to the liver through the portal and are retained less by the adipose tissue, that they are used more in energy production, and that the glucose that is not used for energy in the process is stored in the liver as glycogen. However, oils composed of medium-chain fatty acids are used for special dietary purposes and are not widely available.

Such oils, usually obtained from coconut oil or palm oil, are used in the treatment of some hyperlipidaemias and malabsorption symptoms, but they can disrupt the transport of vitamin E and amino acids because they are transported with serum albumin and saturate it [Linscheer, 1988].

Despite the fact that in some studies it has been shown that addition of fat to potatoes or other foods rich in CHO affects glucose and insulin response [Collier, 1983; Flatt, 1985; Gannon, 1993; Nuttall, 1991], the oils added in those studies consisted of either butter or medium-chain fatty acids and the amount was 50 g.

We, however, used sunflower oil and added 20 ml. We wanted to try this oil as 50 ml, but the patients could not have the potato puree mixed with so much fat.

As a result, adding moderate quantities of sunflower oil (20 ml) to potatoes, a commonly used carbohydrate source with a high glycaemic index, does not affect glucose and insulin response in type II diabetics.

4. Conclusion

It has been seen that, there is not a difference in terms of serum glucose and insulin responses in the type II diabetic patients when they are only fed boiled potatoes, a food with high glycaemic index, compared to when the boiled potato is added 20ml of sunflower oil. In other words, the addition of oil to potatoes did not significantly affect serum glucose and insulin levels. No statistically significant relationship was found between them ($p>0.05$).

As can be understood from this study, when regulating the diet of the type II diabetic patients, it should be planned considering the glycaemic index of the food given as it is, since adding fat to the food does not affect the serum glucose and insulin response.

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