

Effect of Dietary Carbohydrate Content and Inulin-Fructooligosaccharide (FOS) Supplementation on Glycemic Control in Individuals with Type 1 Diabetes Mellitus

Study Summary:

Diabetes is a chronic metabolic disease in which nutrients such as carbohydrates, fats and proteins cannot be utilized sufficiently due to the inability to produce insulin or defects in the effect of the produced insulin. The risk of individuals encountering complications related to diabetes decreases when glycemic control is achieved in these patients. Therefore, nutrition is an necessary component of treatment. Although there are many studies in the literature examining the effect of carbohydrate intake on glycemic control in individuals with diabetes and monitoring carbohydrate intake in individuals with diabetes is the basic strategy for reaching glucose targets, a common denominator has not yet been reached for the optimal amount of carbohydrate intake for individuals with diabetes. There are a wide range of definitions regarding carbohydrate intake and studies on carbohydrate restriction, especially in individuals with Type 1 diabetes, are limited. It has been reported that inulin type fructans may be associated with lower HOMA-IR, HbA1c and FPG levels through reducing gastric emptying rate, improve the microbiota, preventing endotoxemia, reducing intestinal permeability, improving general health status through short-chain fatty acids formed as a result of fermentation, protecting pancreatic islet cells by reducing inflammation, suppressing hepatic glucose release and affecting glucagon-like peptide (GLP-1) and glucagon-like peptide 2 (GLP-2) levels.

In this proposed randomized crossover study, three isocaloric different dietary treatment are planned to applied for 2 weeks in which (i) 30% of the daily energy requirement is provided from carbohydrates, not to fall below 130 g/day carbohydrates according to the individual characteristics of the patients, (ii) 50-55% of the daily energy requirement is provided from carbohydrates and (iii) carbohydrate content in the diet is adjusted without increasing the amount of carbohydrates, by supplementing 2 sachets (1 sachet 3.68 g inulin + 3.68 g) where 50-55% of daily energy requirement is provided from carbohydrates together with fructooligosaccharide (FOS)) inulin-fructooligosaccharide (FOS) supplementation. A 2-week washout period is planned between each diet model. The research will be conducted with 30 individuals with Type 1 diabetes using a Continuous Glucose Monitoring device. The proposed project aims to investigate the effect of different dietary treatments on glycemic control in individuals with Type 1 diabetes by using a continuous glucose measuring device. At the end of each dietary treatment application, the data obtained from the Continuous Glucose Measuring Device will be evaluated as the primary outcomes; total insulin dose, insulin/Carbohydrate ratio, total bolus insulin dose will be evaluated as the secondary outcomes. As a result of the research, the potential effects of different dietary treatments on glycemic control will be evaluated and the development of the most appropriate diet model for these patients will be contributed. In addition, this research will contribute to the improvement of the continuous glucose monitoring device.

Study Protocol:

Inclusion criteria:

- Patients aged 18-65 years diagnosed with type 1 diabetes mellitus and currently using a continuous glucose monitoring device

Exclusion criteria:

- Individuals with type 2 diabetes
- Individuals with gestational diabetes
- Individuals with celiac disease
- Breastfeeding individuals
- Renal insufficiency ($\text{tGFR} \leq 60 \text{ ml/min/1.73 m}^2$)
- Diagnosis of liver failure
- Immunodeficiency
- Individuals with malignancy
- Individuals with gastroparesis
- Individuals using nutritional supplements that may affect metabolic parameters

Study Design:

Present study aims to implement three different dietary models for patients with type 1 diabetes over 2-week periods. These models include a carbohydrate-restricted diet (130g/day), a diet where 50-55% of daily energy requirements come from carbohydrates (selected from the reference range - 45-60% of daily energy requirements come from carbohydrates), and an isocaloric diet model where the carbohydrate amount is not changed but supplemented with 3 sachets of inulin (1 sachet = 3.68g inulin). A 2-week wash out period is planned between each diet model, and participants are required to continue using their existing continuous glucose monitoring devices during the dietary intervention. To assess adherence to the diet, three weekly phone calls will be conducted, one of which will be on a weekend, and a total of seven calls will be planned for each diet period, with food consumption records being collected. The study will investigate dietary carbohydrate and fiber intake, anthropometric measurements and body composition, total insulin doses, K/I ratio, TIR (time spent at target/70-180 mg/dl), TAR 180 (time spent above 180 mg/dl target), TAR 250 (time spent above 250 mg/dl target), TBR 70 (time spent below 70 mg/dl), TBR 54 (time spent below 54 mg/dl), and standard deviation or CV (coefficient of variation). Additionally, total insulin dose, bolus insulin dose, and K/I ratio will be compared across three different dietary treatments.

Randomized Design

30 participants will undergo three different dietary models with 2-week washout periods. The study plans to have three arms:

- Intervention 1 diet: Dietary treatment containing 130 g/day of carbohydrates
- Intervention 2 diet: Dietary treatment where 50-55% of daily energy requirements are provided by carbohydrates
- Intervention 3 diet: Dietary treatment where 50-55% of daily energy requirements are provided by carbohydrates, with the addition of 3 sachets (1 sachet 3.68g inulin) of inulin to the diet, without increasing the amount of carbohydrates.

Anthropometric Measurements

Individuals' height will be measured in cm with a height measuring device with 1 cm accuracy, with feet together and the head in the Frankfurt plane (eye triangle and earlobe aligned, parallel to the ground), without shoes. A body analysis device will be used to measure the body weight and evaluate the body composition of individuals. Body weights will be measured in the morning on an empty stomach and without shoes. Before the measurement, the device will be adjusted to subtract 0.5-1.0 kg from the weight depending on the clothing worn by the individuals. The measurement will be taken with 0.1 g accuracy, and in addition to body weight, body fat and lean tissue will be determined (% and kg) using bioelectrical impedance analysis (BIA). The following points will be considered when performing body composition analysis:

- Body composition analyses will be performed after an 8-hour fasting period and at the same time of day (immediately before the blood sampling).
- Individuals will be instructed not to consume alcohol in the 24 hours prior to the analysis.
- All metal objects (accessories, watches, etc.) will be removed from individuals before the analysis.
- During the analysis, attention will be paid to ensuring individuals maintain the correct body position; they will be guided to stand with their arms at a 30° angle to their torso and their legs at a 45° angle.

Dietary Adherence Monitoring:

To monitor the adherence to the diet, a 1-day food consumption record will be taken and analyzed by the researcher at each interview. At the beginning of the diet treatment, there will be 3 telephone interviews per week, one of which will be on the weekend. A total of 7 consultations are planned for each diet period. A food consumption record will be taken by the researcher at each interview.