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Original article

# The effect of high performance inulin on appetite, energy intake and anthropometric indices in patient with type 2 diabetes

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**Summary.** *Aim:* This trial was conducted to evaluate the effects of high performance inulin on anthropometric indices and appetite status in patient with type 2 diabetes. *Methods:* Forty six patients with type 2 diabetes were randomly assigned to two groups. Subjects received 10g/d high performance inulin (n=23) or 10 g/d placebo (n=23) for 8 week. Anthropometric indices were measured at baseline and after 8 weeks. Dietary intakes and appetite status were evaluated by food records and Visual Analogues Scale recpectivly. *Results:* After 8 weeks, in the high performance inulin group there were a significant decrease in waist circumference, hip circumference, energy intake and Total Satiety score compared to placebo group. Interagroup analysis showed that a significant decrease in energy intake. *Conclusion:* high performance inulin may improve body weight, anthropometric indices and appetite statues in type 2 diabetic patients.

**Key words:** high performance inulin, anthropometric indices, appetite, type 2 diabetes

## Introduction

Diabetes mellitus (DM) which is a complex metabolic disorder influenced by various factors such as environmental factors and genetic and has become a common health problem throughout the world (1). In recent reports it is estimated that by the year 2030 at least 366 million people will suffer from diabetes(2). Recent scientific advances point to manipulation of gut microbiota as contributing factors for prevention or controlling of diabetes(3, 4). The intestinal microbiota is a vital organ with trillions of commensally microorganisms which are involved in wide functions of host metabolism(5). Nowadays, dietary components, in particular prebiotics considered as functional foods that provide a health beneficial effects on intestinal tract beyond basic nutrition(6) A prebiotic was defined as "a non-viable food component that confers a health benefit on the host associated with modulation of the microbiota" (7) Inulin-type fructans belong to prebiotic fibers and has received much attention in the last decades. Inulin (a mixture of fructo oligo- and polysaccharides) that is a very interesting functional ingredient, being present as storage carbohydrate in more than 30,000 vegetable and fruit species such as garlic, chicory root, wheat and banana(8, 9). A more refined type of inulin is high performance (HP) inulin. It has an average degree of polymerization of 25 monosaccharide units. This form of inulin causes high advantage with less gastrointestinal side effects such as abdominal tension(10). Our understanding of the molecular mechanisms regulating body weight provides potential opportunities for therapeutic development and renewed hope for potential dietary intervention. Current recommendations for the management of diabetes mellitus include an increase in dietary fibre in-

take, which may contribute to improvement of glycemic control in these patients(11). Previous studies have demonstrated that inulin supplementation maight be helpful in the control of plurimetabolic syndrome associated with diabetes mellitus(12).

Hunger and food intake are regulated by multifactorial physiological and component of diet in particular dietary fiber seem to be an important factor(13).

Previous studies has shown that improvement in waist circumference and waist and hip circumferences together or not together with body weight can be cause improve conditions in diabetic patients(14). Therefore the aim of study was evaluation of the effect of high performance inulin on appetite, Energy intake anthropometric indices in patient with type 2 diabetes.

## Methods and materials

*Patients and study design*

In this randomized, double-blind, placebo-controlled trial, 46 volunteer diabetic adult patients who were referred to diabetes clinics in East Azerbaijan, Iran, during September 2016 and November 2016, were recruited. The inclusion criteria were having diabetes mellitus > 6 months; aged 30 to 50 years; body mass index greater than 25 and less than 35. Exclusion criteria were kidney disease; liver failure; heart failure; rheumatic diseases inflammatory diseases of the gastrointestinal tract; lactose intolerance; insulin injection and drugs consumption: estrogen, progesterone, corticosteroids; smoking; breast feeding and pregnancy; vitamins, minerals, omega-3 and antibiotics supplementation for three weeks before the start of the study. The protocol of research was approved by Ethic Committee of Tabriz University of Medical Science (Ethic code: IR.TBZMED.REC.1395.671) and was registered in the Iranian Registry of Clinical Trials website (IRCT ID: 201610212017N31).

A written informed consent document was obtained from all patients. The eligible participants were randomly allocated using randomized block procedure to one of two treatment orders (intervention or placebo groups) based on random block procedure produced by Random Allocation Software (RAS). With Confidence Interval: 95% & Power: 90%, calculation of the sample size was done based on fasting insulin parameter(15). The formula: $N = [(Z1 - \alpha/2 + Z1 - \beta)2 (SD12 + S D22)]/\Delta 2$ was used to calculate the 23 samples for each group with counting 6 person for withdrawals. Intervention group received 10 g/day HP inulin supplement powder (Sensus, Borchwef 3, 4704 RG Roosendaal the Netherlands) as well as placebo group consumed 10g starch powder as placebo for 8 consecutive weeks.

*Anthropometric measurements*

At the onset and end of the trial, anthropometric indices such as body weight (BW), height, waist and hip circumferences (WC and HC respectively), waist to hip ratio (WHR) and body mass index (BMI) were recorded. BW was recorded using a Seca scale to the nearest 0.1kg in fasting state with light cloth and no shoes. Height was measured on a mounted tape to the nearest 0.5cm. With using plasticized non elastic measuring tape waist and hip circumference was measured accurate to 0.5 cm.

*Dietary history and analysis*

The dietary intakes were collected from 3-days food records (non-consecutive days including one weekend day) before and after the intervention. Data were analyzed by nutritionist IV software for the determination of energy, protein, total fat and carbohydrate.

*Appetite measurements*

Appetite status was evaluated by VAS (Visual Analogous Scale) that spesefity and validity of this questionnaire was evaluated, appetite status was assessed in six aspect included: Feeling hungry, satiety, Eating desire, The desire for salty foods, The desire for sweet foods and The desire for high-fat foods. Each part of the questionnaire had 10 points and Total satiety score was 60 and calculated with this formula: (100- satiety) + Eating desire+ Feeling hungry/3(16, 17).

## Results

The study flowchart has been shown in Figure 1. Anthropometric characteristics of subjects are presented

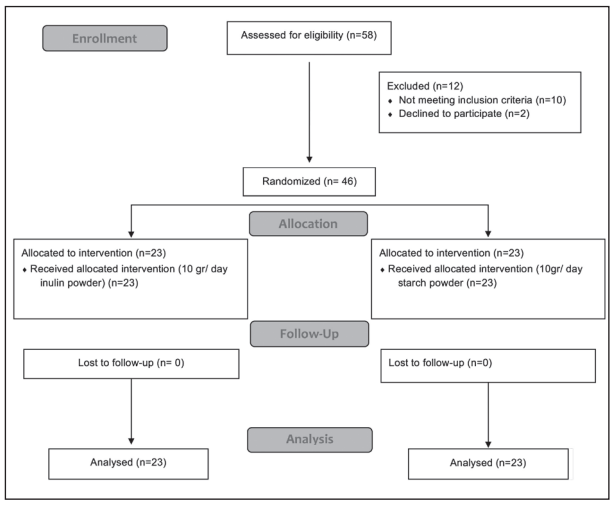


**Figure 1**: Flowchart of design and protocol of the study

in (Table 1). Intra-group analysis showed that there was a significant difference between the waist circumference, hip circumference, Body mass index, energy intakes and Total satiety score in the Inulin Group. Intra-group statistical analysis showed that there was a significant difference in energy intake. Although Statistical analysis showed that inulin supplementation didn't have any significant effects on appetite and anthropometric indices compared to the placebo group (Table 2, 3).

## Discussion

This clinical trial showed that the high performance inulin supplementation for 8 week in diabetic patients decreased significantly WC, BMI and HC in inulin group although this difference was not significantly compared to placebo group, also result showed inulin supplementation causes to decrease in energy intake.

We could not find any significant effect on some aspects of appetite although differences in Total satiety score were significant in inulin group.

In our study, energy intake and BMI, WC and HC of the high performance inulin group were significantly decreased. Although this intervention causes a significantly decreased in energy intake and BMI in intervention group but it was not significantly in compared to placebo group Aliasgharzadeh and colleagues reported that inulin resulted in significant decrease in BMI but they did not find any significant decrease

**Table 1.** Anthropometric variables following Inulin supplementation.

| Variables | | Groups | | | | P * | P** |
|---|---|---|---|---|---|---|---|
| | | Intervention | | Placebo | | | |
| | | mean±SD | Percent change | mean±SD | Percent change | | |
| BMI (kg/m$^2$) | Before | 30.37± 2.47 | -0.71 | 30.86± 2.41 | -0.62 | 0.752 | 0.742 |
| | After | 29.15± 2.73 | | 30.64± 2.24 | | | |
| | P-value■ | 0.004 | | 0.084 | | | |
| WC(cm) | Before | 97.47± 8.41 | -1.17 | 93.84± 11.16 | -0.003 | 0.467 | 0.952 |
| | After | 96.28± 8.03 | | 93.68± 9.98 | | | |
| | P-value■ | 0.009 | | 0.846 | | | |
| HC(cm) | Before | 108.04± 7.39 | -1.93 | 104.50± 10.70 | -1.17 | 0.455 | 0.687 |
| | After | 106± 8.23 | | 103.22± 10.47 | | | |
| | P-value■ | 0.004 | | 0.061 | | | |
| WHR | Before | 0.90± 0.08 | -0.21 | 0.88± 0.07 | -1.28 | 0.455 | 0.192 |
| | After | 0.90± 0.08 | | 0.87± 0.05 | | | |
| | P-value■ | 0.744 | | 0.135 | | | |
| | After | 178.24± 55.01 | | 176.18± 31.02 | | | |
| | P-value■ | 0.122 | | 0.742 | | | |

■ *P-value was reported based on Paired Sample T test. * P-value was reported based on ANCOVA after adjustment by baseline values. ** P-value was reported based on ANCOVA after adjustment by baseline values, age and gender.*
*BMI: Body Mass Index; WC: Waist Circumference; HC: Hip Circumference; WHR: Waist to Hip Ratio*

**Table 2.** appetite status following Inulin supplementation.

| Variables | | Groups | | | | P* |
|---|---|---|---|---|---|---|
| | | Intervention | | Placebo | | |
| | | mean±SD | Percent change | mean±SD | Percent change | |
| Feeling hungry | Before | 73.18±28.43 | 23.78 | 77.13±38.31 | 25.11 | 0.111 |
| | After | 75.87±32.65 | | 78.32±41.14 | | |
| | P-value■ | 0.112 | | 0.654 | | |
| satiety | Before | 20.45±11.23 | 16.65 | 27.32±21.07 | 17.07 | 0.665 |
| | After | 21.67±14.21 | | 26.35±15.13 | | |
| | p-value■ | 0.345 | | 0.660 | | |
| Eating desire | Before | 62.59±27.72 | 17.87 | 55.34±20.28 | 18.62 | 0.942 |
| | After | 62.40±26.62 | | 60.35±14.19 | | |
| | p-value■ | 0.708 | | 0.594 | | |
| The desire for salty food | Before | 31.81±19.20 | 39.68 | 28.52±20.24 | 54.15 | 0.693 |
| | After | 34.32±27.07 | | 31.35±19.13 | | |
| | p-value■ | 0.766 | | 0.302 | | |
| The desire for sweet food | Before | 28.81±16.20 | 14.76 | 27.32±21.07 | 16.87 | 0.876 |
| | After | 28.52±17.24 | | 26.35±15.13 | | |
| | P-value■ | 0.580 | | 0.660 | | |
| The desire for high-fat foods | Before | 41.59±21.72 | 12.13 | 45.23±21.12 | 10.42 | 0.454 |
| | After | 38.40±19.62 | | 38.11±11.11 | | |
| | P-value■ | 0.687 | | 0.654 | | |
| TSS | Before | 56.81±24.23 | 39.68 | 57.52±25.11 | 43.87 | 0.654 |
| | After | 42.32±27.00 | | 57.35±30.15 | | |
| | P-value■ | 0.049 | | 0.765 | | |

■ *P-value was reported based on Paired Sample T test. * P-value was reported based on ANCOVA after adjustment by baseline values. TSC: Total Satiety Score*

in other anthropometric indices in pre diabetic patients(18). Gues and colleagues reported that 30 gr/day for 18 week inulin type- fructans in patients with type 2 diabetes was resulted in decrease in body weight, WC and HC(15). We found different result with other studies that it may be due to differences between species, duration of supplementation.

The exact mechanism(s) of weight reduction by high performance inulin remains vague. Some gut satiety hormones that is released as response to diet composition, including glucagon-like peptide (GLP-1), Peptide YY (PYY), and ghrelin, and fermentation of high performance inulin in the large bowel to short chain fatty acids (SCFAs) are proposed for weight reduction and improve in anthropometric indices related with type 2 diabetes.

In our study, we did not find any significant differences in some aspects of appetite but we found a significant decrease in Total Satiety Score in inulin group in compared to placebo group. Hume and collogues reported that 8gr/day inulin for 16 week in obese girls was resulted in a significant increase in satiety and significant decrease in energy intake(19). Liber and collogues in a meta-analysis included 4 clinical trial for pediatric and 15 clinical trial for adults that examined the effect of inulin supplementation on appetite status. The result of this meta-analysis showed a significant decrease in pediatric although they did not find any significant differences in adults(20). Increase in production of Short Chain Fatty Acids in large bowel due to fermentation of inulin and Some gut satiety hormones that is released as response to diet composition, including glucagon-like peptide (GLP-1), Peptide YY (PYY), and ghrelin are proposed for

**Table 3.** Anthropometric variables following Inulin supplementation.

| Variable | | Group | | | | P * | P ** |
|---|---|---|---|---|---|---|---|
| | | Intervention | | Placebo | | | |
| | | mean±SD | Percent change | mean±SD | Percent change | | |
| Energy(Kcal) | Before | 1595.48±581.05 | 8.80 | 1748.23±439 | 15.43 | 0.039 | |
| | After | 1257.14±631.62 | | 1298.63±401.36 | | | |
| | P-value■ | 0.010 | | 0.063 | | | |
| Carbohydrate(gr) | Before | 242.49±124.98 | 12.07 | 244.45±91.55 | 20.34 | 0.547 | |
| | After | 276.13±138.36 | | 276.13±98.18 | | | |
| | P-value■ | 0.638 | | 0.125 | | | |
| Protein(gr) | Before | 62.59±27.72 | 17.87 | 55.34±20.28 | 18.62 | 0.942 | |
| | After | 62.40±26.62 | | 60.35±14.19 | | | |
| | P-value■ | 0.708 | | 0.594 | | | |
| Fat(gr) | Before | 31.38±19.20 | 39.68 | 28.52±20.24 | 54.15 | 0.693 | |
| | After | 34.32±27.07 | | 31.35±19.13 | | | |
| | P-value■ | 0.766 | | 0.302 | | | |
| | After | 178.24± 55.01 | | 176.18± 31.02 | | | |
| | P-value■ | 0.122 | | 0.742 | | | |

■ *P-value was reported based on Paired Sample T test. * P-value was reported based on ANCOVA after adjustment by baseline values.*

the likely effect of inulin supplementation on appetite status in human.

## Conclusion

Based on the results of this trial, high performance inulin may improve body weight, anthropometric indices and appetite statues in type 2 diabetic patients. This finding proposes a safe and effective therapy in diabetes management and its complications. Obviously, more investigations are needed for confirmation of positive effects of high performance metabolic status in diabetic patients and clarify its underling mechanism(s).

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