# การศึกษาประสิทธิผลของแก่นตะวันต่อระดับน้ำตาลในเลือดในผู้ป่วยก่อนเบาหวาน

# The Efficacy of Jerusalem artichoke on The Level of Blood Glucose and HbA1c in Pre-Diabetes Patients

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**บทคัดย่อ**

แก่นตะวันเป็นพืชที่มีสารอาหารอันเป็นประโยชน์แก่ร่างกาย ในหัวของแก่นตะวัน มีสารสำคัญ คือ อินนูลิน (Inulin) เป็นน้ำตาลเชิงซ้อน คือมีโมเลกุลของน้ำตาลต่อกันเป็นห่วงโซ่มากกว่า 10 โมเลกุล ลักษณะเช่นนี้ทำให้แก่นตะวันกลายเป็นอาหารที่มีสารเส้นใยสูง งานวิจัยนี้ต้องการศึกษาประสิทธิผลของแก่นตะวันต่อการลดลงของระดับน้ำตาลในเลือดในผู้ป่วยก่อนเบาหวาน ผู้เข้าร่วมวิจัยถูกแบ่งเป็นสองกลุ่มโดยการสุ่ม ทั้งสองกลุ่มไม่ทราบว่าตัวเองจัดอยู่กลุ่มใด กลุ่มทดลองจะได้รับแคปซูลแก่นตะวันในปริมาณ 10 กรัมต่อวันแบ่งรับประทานเป็นสามมื้อก่อนอาหารและก่อนนอน กลุ่มควบคุมจะได้รับยาหลอกในปริมาณและการรับประทานที่เท่ากัน ผลการทดลองพบว่าระดับน้ำตาลสะสม(HbA1c) ลดลงในกลุ่มทดลองแต่เมื่อเปรียบเทียบกับกับกลุ่มควบคุมยังไม่มีความแตกต่าง ผลของระดับน้ำตาลในเลือด (FBS) ระหว่างกลุ่มทดลองกับกลุ่มควบคุมไม่แตกต่างกัน เมื่อเปรียบเทียบระหว่างสัปดาห์ภายในกลุ่มควบคุมระหว่างสัปดาห์ที่ 0 กับ 4 สัปดาห์ที่ 4 กับ 8 และสัปดาห์ที่ 0 กับ 8 พบว่าระดับน้ำตาลไม่ลดลง แต่เมื่อเปรียบเทียบภายในกลุ่มทดลอง ระหว่างสัปดาห์ที่ 0 กับสัปดาห์ที่ 4 ระดับน้ำตาลในเลือดลดลงอย่างมีนัยสำคัญทางสถิติ ในสัปดาห์ที่ 4 ถึงสัปดาห์ที่ 8 ระดับน้ำตาลเพิ่มขึ้นมาเล็กน้อย และเมื่อ

เปรียบเทียบ ระหว่างสัปดาห์ที่ 0 กับสัปดาห์ที่ 8 ระดับน้ำตาลในเลือดยังคงลดลงอย่างมีนัยสำคัญทางสถิติ สรุปผลงานวิจัยครั้งนี้ พบว่าการรับทานแคปซูลแก่นตะวันในผู้ป่วยก่อนเบาหวาน สามารถลดระดับน้ำตาลในเลือดได้สูงสุดในสัปดาห์ที่ 4 และ ในสัปดาห์ที่ 8 ระดับน้ำตาลยังคงมีระดับลดลงเมื่อเทียบกับช่วงเวลาก่อนรับประทานแคปซูลแก่นตะวัน

**คำสำคัญ :** แก่นตะวัน/อินนูลิน/ระดับน้ำตาลในเลือด/ระดับน้ำตาลสะสม/ผู้ป่วยก่อนบาหวาน

| | |
|---|---|
| Thesis Title | The Efficacy of Jerusalem Artichoke Decreasing the Level of Blood Glucose and HbA1c in Pre-diabetes Patients |
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| Degree | Master of Science (Anti-Aging and Regenerative Science) |
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**Abstract**

Jerusalem Artichoke (*Helianthus tuberosus* ) is a great source of fiber, containing high level of inulin and oligofructose and is considered as a functional food which can promote health. This study was carried out to investigate the efficacy of Jerusalem Artichoke (JA) on decreasing of blood glucose and HbA1c in pre-diabetes patients. 10 pre-diabetes subjects were requited and randomly divided into two groups, the treatment group and the control group. One group takes JA and the other group placebo 2.5 grams before meals four times daily which equal to 10 grams/day for 8 weeks. The measurements were taken at week 0, 4, 8 for FBS and 0, 8 for HbA1c. On the basis of the result, the HbA1c level after taking JA was decreased in treatment group but not statistically significant while in the control group was increased. And there is no difference between two groups. The FBS between treatment group and control group were no difference. When comparing within groups, FBS in control group with week 0 vs. 4, 4 vs. 8 and 0 vs. 8 there were no differences whereas in the treatment group was decreased significantly by comparing week 0 and week 4 ($p<0.05$). When determine the result pairing week 0 with week $8^{th}$ there was significantly lowered ($p<0.05$). The oral administration of JA in pre-diabetes patient can reduce blood glucose at the end of 8 week and will be most effective time on week $4^{th}$ and also on week $8^{th}$ still decreasing when compared with week 0.

**Keyword:** Jerusalem Artichoke/ FBS/ HbA1c/Pre-diabetes

## Introduction

The number of Thai people who were dead from diabetes disease are 11,389 or on the average of 17.53% per one hundred thousand populations (Bureau of Non Communicable Disease, 2014). The type 2 diabetes can be asymptomatic and consequently remain undiagnosed for several years. Most of the time people come with complications often apparent at the time of diagnosis. Due to diet, stress and the environment caused diabetes has increased steadily. The approximate 1.3 million people are unaware that they are pre-diabetic and having never been detected in the blood sugar level before (Thai Health Promotion Foundation, 2014).

Pre-diabetes, defined as having a blood glucose concentration higher than normal but not high enough to be classified as diabetes. However the kidneys and nerves already damage at pre-diabetic stage (Tabak et al.,2012) and has been associated with poorer cardiovascular outcomes (Giraldez et al., 2013). Pre-diabetes can lead to heart disease, stroke, kidney failure, high blood pressure, and blindness (Murray et al.,2010).

The goals of management for pre-diabetes emphasize on the importance of food choices and facilitate weight loss. Several studies of people with pre-diabetes show that decrease their blood glucose level can improve their health (Chen & Huang, 2005).

High-fiber foods may be benefit in the management of diabetes mellitus. Plant fibers have important influences on gastrointestinal physiology and the absorption of various nutrients. Therefore intake of plant fibers could lowers plasma glucose and decreases glycosuria (Jame et al., 1979) which has been associated with improve insulin sensitivity, an ability to secrete insulin sufficiently to overcome insulin resistance (Mayer-Davis et al.,2006).

Jerusalem artichoke (JA) is a source of fiber, containing high of inulin , oligofructose and fructose. (Panchev et al., 2011). Inulin is a great potential to be considered as a low glycaemic index (GI) (Barclay et al., 2008; Watzl, Girrbach, & Roller, 2005) and used in the food industry as a foam/emulsion stabilizer, and fat/sugar replacer, while promoting the best possible health outcomes (Mantzouridou & Vassilios Kiosseoglou, 2012). It is discover that some

bioactive ingredients can be extracted from its leaves and stems, which creates an opportunity for applications in the pharmaceutical sector (Pan et al., 2009).

In order to identify new effective treatments and alternative medication, this study aimed to determine the efficacy of Jerusalem artichoke to decrease the level of blood glucose in pre-diabetes patients.

**The Purpose of the Study**

The purpose of this study was to determine the efficacy of the Jerusalem artichoke on the level of blood glucose and HbA1c in pre-diabetes patients.

**Scope of the Study**

This study enrolled ten volunteers aged between 25 to 55 years old at Phyathai Hospital, Bangkok, Thailand. Fasting plasma glucose in participants measured after 8-10 hours were in between 100-125 mg/dL considerably as Pre-diabetes or Impaired Fasting Glucose. The period of this study is in 8 weeks. The treatment group had given capsules supplement of Jerusalem artichoke (JA). And the control group had placebo (Carboxymethyl Cellulose, CMC). The participants health's characteristic and blood glucose level were collected before and after taking JA. All participants do not have to change health behaviors in daily life basis.

**Research Design**

This research was Clinical controlled trial. Physical examination was evaluating blood tests done by specialist nurse. Examine Plasma glucose in week 0, 4 and 8 also HbA1c blood test in weeks 0 and 8. Participants will be having JA 10 grams/day 500 milligram 5 capsules before meals for four times daily for the first week. After week 1, physical test and blood result will be given to participant. And then distribute JA 10 grams/day for another 3 weeks. After week 4, participants will get the rest of JA for another 4 weeks and follow-up physical side effect, if occur. After complete week 8, participants will be appointed for the final Plasma glucose and Hemoglobin A1c (HbA1c) blood test.

**Statistical Analysis**

The data collected included participants' gender, age, body mass index (BMI), Fasting Blood Sugar level (FBS), and HbA1c level. The general characteristic of subjects is performed by using descriptive analysis. Comparison the average of BMI, HbA1c before and after taking JA was use Paired t-test meanwhile comparison between treatment group and control group was used Independent-test. Comparison the average of FBS on week 0, 4, 8 between treatment group and control group was use Independent-test whereas comparison the average of FBS on week 0 vs. 4, week 0 vs. 8 and week 4 vs. 8 in treatment group and also control group were used Paired t-test. Level of significance of all tests was set at 0.05 levels.

**Results**

**Participants' Characteristics**

**Table 4.1The general characteristic of pre-diabetes subjects**

| Characteristic | Treatment (n=5) | | Control (n=5) | |
|---|---|---|---|---|
| | Number | Percent | Number | Percent |
| Gender | | | | |
| Male | 4 | 80.0 | 0 | 0 |
| Female | 1 | 20.0 | 5 | 100.0 |
| Age (years) | | | | |
| < 35 | 2 | 40.0 | 3 | 60.0 |
| ≥ 35 | 3 | 60.0 | 2 | 40.0 |
| Mean±S.D. (Min-Max) | 39.0±11.25 (26-55) | | 37.0±9.30 (26-49) | |
| BMI $kg/m^2$ | | | | |
| Normal ( ≥18.5 – 24.99 ) | 0 | 0 | 1 | 20.0 |
| Overweight (≥ 25-29.99 ) | 3 | 60.0 | 4 | 80.0 |
| Obesity (≥ 30 ) | 2 | 40.0 | 0 | 0 |
| Mean±S.D. (Min-Max) | 31.76±5.40 (25.91-39.25) | | 28.19±2.61 (23.92-29.97) | |
| Drink Alcohol | 1 | 20.0 | 1 | 20.0 |
| Smoking | 2 | 40.0 | 0 | 0 |

Table 4.1 describe the general characteristic of subjects is performed by using descriptive analysis. Treatment group has 4 males and 1 female while control group have 5 female. Considered by ages there is not much difference between two groups with 39.0±11.25 years, age from 26 to 55 years in treatment group and 37.0±9.30 years, age from 26 to 49 year in control group. Treatment group had BMI index mean standard was 31.76±5.40 kg/m$^2$ range from 25.91 to 39.25 kg/m$^2$ more than the control group was 28.19±2.61 kg/m$^2$ range from 23.92 to 29.97 kg/m$^2$. Each one subject from both groups had alcohol history. And two subject of treatment group had smoking history.

### 4.2 HbA1c analysis

**Table 4.2.1 Comparison of the average of BMI, HbA1c in mg% before and after taking JA (n=5)**

| | Before taking JA | | After taking JA | | | | |
|---|---|---|---|---|---|---|---|
| | $\overline{X}$ | S.D. | $\overline{X}$ | S.D. | df | T | p-value |
| Treatment | | | | | | | |
| **BMI** | 31.76 | 5.40 | 31.58 | 5.34 | 4 | 0.922 | 0.409 |
| **HbA1C** | 6.18 | 0.27 | 6.06 | 0.21 | 4 | 2.058 | 0.109 |
| Control | | | | | | | |
| **BMI** | 28.19 | 2.61 | 27.15 | 2.88 | 4 | 1.254 | 0.278 |
| **HbA1C** | 6.10 | 0.29 | 6.18 | 0.31 | 4 | 2.138 | 0.099 |

**p-value from Paired t-test**

Table 4.2.1 showed the average of BMI, HbA1c before and after taking JA using Paired t-test found that in the treatment group BMI measurement before taking JA the average was 31.76 kg/m$^2$ standard deviation was 5.40, after taking JA the average was 31.58 kg/m$^2$ standard deviation was 5.34 kg/m$^2$, p-value was equal to 0.409. HbA1c measurement before taking JA the average was 6.18 mg%, standard deviation was 0.27 mg%, after taking JA the average was 6.06 mg%, standard deviation was 0.21 mg%, and p-value was equal to 0.109. In the control group BMI measurement before taking JA the average was 28.19 kg/m$^2$, standard deviation was 2.61 kg/m$^2$, after taking JA the average was 27.15 kg/m$^2$, standard deviation was 2.88 kg/m$^2$, p-value

was equal to 0.278. HbA1c measurement before taking JA the average was 6.10 mg%, standard deviation was 0.29 mg%, after taking Jerusalem artichoke the average was 6.18 mg%, standard deviation was 0.31 mg%, and p-value was equal to 0.099.

There was no statically significant difference between the average of BMI, HbA1c per mg% before and after taking JA.

**Table 4.2.2 Comparison of the average of BMI, HbA1c in mg% between treatment group and control group (n=5)**

| | Treatment | | Control | | | | |
|---|---|---|---|---|---|---|---|
| | $\overline{X}$ | **S.D.** | $\overline{X}$ | **S.D.** | **df** | **t** | **p-value** |
| **Before taking JA** | | | | | | | |
| **BMI** | 31.76 | 5.40 | 28.19 | 2.61 | 8 | 1.334 | 0.219 |
| **HbA1C** | 6.18 | 0.27 | 6.10 | 0.29 | 8 | 0.451 | 0.664 |
| **After taking JA** | | | | | | | |
| **BMI** | 31.58 | 5.34 | 27.15 | 2.88 | 8 | 1.629 | 0.142 |
| **HbA1C** | 6.06 | 0.21 | 6.18 | 0.31 | 8 | 0.717 | 0.494 |

**p-value from Independent t-test**

Table 4.2.2 showed the average of BMI, HbA1c between treatment group and control group by using Independent t-test found that before taking JA BMI measurement in the treatment group the average was 31.76 kg/m$^2$ standard deviation was 5.40 kg/m$^2$, in the control group the average was 28.19 kg/m$^2$ standard deviation was 2.61 kg/m$^2$, p-value was equal to 0.219. HbA1c measurement in the treatment group the average was 6.18 mg% standard deviation was 0.27 mg%, in the control group the average was 6.10 mg%, standard deviation was 0.29 mg%, p-value was equal to 0.664. After taking JA BMI measurement in the treatment group the average was 31.58 kg/m$^2$, standard deviation was 5.34 kg/m$^2$, in the control group the average was 27.15 kg/m$^2$, standard deviation was 2.88 kg/m$^2$, p-value was equal to 0.142. HbA1c measurement in the treatment group the average was 6.06 mg% standard deviation was 0.21 mg%, in the control group the average was 6.18 mg%, standard deviation was 0.31 mg%, and p-value was equal to 0.494.

There was no statically significant difference between the average of BMI, HbA1c per mg% between treatment group and control group.

## 4.3 Fasting Blood Sugar analysis

**Table 4.3.1 Comparison the average of FBS in mg/dL on week 0, 4, 8 between treatment group and control group (n=5)**

| | Treatment | | Control | | | | |
|---|---|---|---|---|---|---|---|
| | $\overline{X}$ | **S.D.** | $\overline{X}$ | **S.D.** | **df** | **t** | **p-value** |
| FBS (week0) | 118.80 | 9.65 | 116.00 | 5.15 | 8 | 0.572 | 0.583 |
| FBS (week4) | 106.00 | 6.60 | 113.00 | 7.81 | 8 | 1.531 | 0.164 |
| FBS (week8) | 112.00 | 8.46 | 118.20 | 2.86 | 8 | 1.553 | 0.159 |

**p-value from Independent t-test**

Table 4.3.1 demonstrated comparison the average of Fasting Blood Sugar (FBS) between treatment group and control group by applying Independent t-test found that FBS on week 0 in the treatment group the average mean FBS was 118.80 mg/dL, standard deviation was 9.65 mg/dL, in the control group the average was 116.00 mg/dL, standard deviation was 5.15 mg/dL, p-value was equal to 0.583. FBS on week 4 in the treatment group the average was 106.00 mg/dL, standard deviation was 6.60 mg/dL, in the control group the average was 113.00 mg/dL, standard deviation was 7.81 mg/dL, and p-value was equal to 0.164. FBS on week 8 in the treatment group the average was 112.00 mg/dL, standard deviation was 8.46 mg/dL, in the control group the average was 118.20 mg/dL, standard deviation was 2.86 mg/dL, and p-value was equal to 0.159.

There was no statically significant between the average of FBS per mg/dL at week 0, 4 and week 8 in between treatment group and control group.

**Table 4.3.2 Comparison of the average of FBS on week 0 vs. 4, week 0 vs. 8 and week 4 vs. 8 in treatment group (n=5)**

| | FBS level (mg/dL) | | | FBS level (mg/dL) | | | | |
|---|---|---|---|---|---|---|---|---|
| **week** | $\overline{X}$ | **S.D.** | **week** | $\overline{X}$ | **S.D.** | **df** | **t** | **p-value** |
| week 0 | 118.80 | 9.65 | week 4 | 106.00 | 6.60 | 4 | 3.906 | ***0.017** |
| | | | week 8 | 112.00 | 8.46 | 4 | 3.059 | ***0.038** |
| week 4 | 106.00 | 6.60 | week 0 | 118.80 | 9.65 | 4 | 3.906 | ***0.017** |
| | | | week 8 | 112.00 | 8.46 | 4 | 1.460 | 0.218 |
| week 8 | 112.00 | 8.46 | week 0 | 118.80 | 9.65 | 4 | 3.059 | ***0.038** |
| | | | week 4 | 106.00 | 6.60 | 4 | 1.460 | 0.218 |

**p-value from Paired t-test**

***=p<0.05**

**Table 4.3.2.1 Comparison of the average of FBS on week 0 vs. 4, week 0 vs. 8 and week 4 vs. 8 in control group (n=5)**

| | FBS level (mg/dL) | | | FBS level (mg/dL) | | | | |
|---|---|---|---|---|---|---|---|---|
| **week** | $\overline{X}$ | **S.D.** | **week** | $\overline{X}$ | **S.D.** | **df** | **t** | **p-value** |
| week 0 | 116.00 | 5.15 | week 4 | 113.00 | 7.81 | 4 | 0.873 | 0.432 |
| | | | week 8 | 118.20 | 2.86 | 4 | 0.961 | 0.391 |
| week 4 | 113.00 | 7.81 | week 0 | 116.00 | 5.15 | 4 | 0.873 | 0.432 |
| | | | week 8 | 118.20 | 2.86 | 4 | 1.518 | 0.204 |
| week 8 | 118.20 | 2.86 | week 0 | 116.00 | 5.15 | 4 | 0.961 | 0.391 |
| | | | week 4 | 113.00 | 7.81 | 4 | 1.518 | 0.204 |

**p-value from Paired t-test**

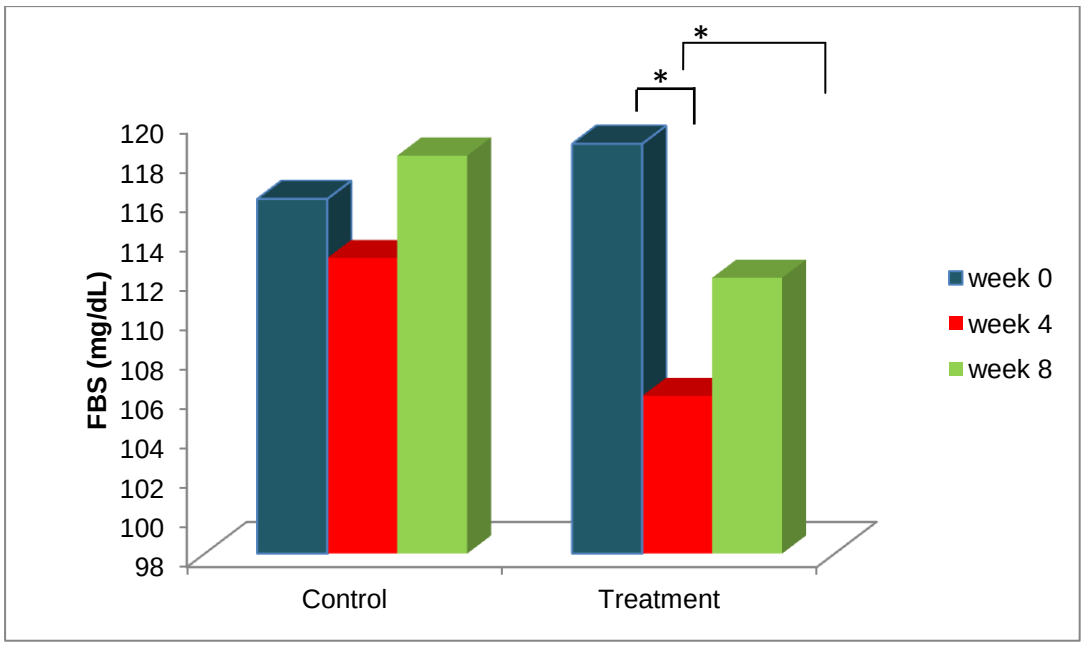


**Figure 4.1 Comparison the average of FBS in mg/dL on week 0 vs. 4, week 0 vs. 8 and week 4 vs. 8 between treatment group and control group (n=5) *=p<0.05**

Table 4.3.2 were the result of Fasting Blood Sugar in the treatment group on week 0 vs.4 the average was 118.80 mg/dL vs.106.00 mg/dL, standard deviation was 9.65 mg/dL vs. 6.60 mg/dL, p-value was equal to 0.017. On week 0 vs.8 the average was 118.80 mg/dL vs. 112.00 mg/dL, standard deviation was 9.65 mg/dL vs. 8.46 mg/dL, p-value was equal to 0.038. On week 4 vs.8 the average was 106.00 mg/dL vs. 112.00 mg/dL, standard deviation was 6.60 mg/dL vs. 8.46 mg/dL, p-value was equal to 0.218. In the control group on week 0 vs.4 the average was 116.00 mg/dL vs. 113.00 mg/dL, standard deviation was 5.15 mg/dL vs. 7.81 mg/dL, p-value was equal to 0.432. On week 0 vs.8 the average was 116.00 mg/dL vs. 118.20 mg/dL, standard deviation was 5.15 mg/dL vs. 2.86 mg/dL, p-value was equal to 0.391. On week 4 vs.8 the average was 113.00 mg/dL vs. 118.20 mg/dL, standard deviation was 7.81 mg/dL vs. 2.86 mg/dL, p-value was equal to 0.204.

The comparison the average of FBS per mg/dL after taking JA on week 0 vs. 4 and week 0 vs. 8 was decreased with statically significance.

**Conclusion and Discussion**

According to the hypothesis of this study, oral capsules supplement of JA will reduce blood glucose and HbA1c levels in pre-diabetes patients. The HbA1c level after taking JA decreased in treatment group but not statistically significant within 8 weeks meanwhile in the control group increased. And there was no statically significant difference between two groups. For the Fasting Blood Sugar (FBS), the result found that taking JA within 8 weeks between treatment group and control group were no difference. When comparing within groups, in control group paired week 0 vs. 4, 4 vs. 8 and 0 vs. 8 there were no differences whereas in the treatment group could make pre-diabetes patients decreased FBS significantly by comparing week 0 and week 4. Complied with Yamashita & co researcher in 1984 that daily intake fructo-oligosaccharides its major component of JA could significantly reduce mean fasting blood glucose within two week. JA might improve insulin sensitivity since inulin was vital component decrease the synthesis of triglycerides and fatty acids in the liver and lowers their circulating levels in rat (Yang et al., 2012). And the fructan of inulin could drop blood glucose in human (Rumessen et al., 1990). Considered that the continuous supply of inulin from JA within 4 week could normalize blood glucose level in Streptozotocin-induced diabetic rats (Park Byung- Sung, 2011). However the result on week 4 up to week 8 the blood glucose level in both group had been slightly increased. On the contrary when determine the fasting blood sugar result pairing week 0 with week $8^{th}$ there was significantly lowered. The oral administration of JA in pre-diabetes confirmed to reduce fasting blood glucose was most effective time at week $4^{th}$ and continue to week $8^{th}$ when compared with week 0, while the control group was increasing from week 0.

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