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Effects of eight weeks of resistance training and cucumber juice consumption on the liver enzymes status of patients with type 2 diabetes mellites

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Abstract

Background: Type 2 diabetes mellitus (T2DM) is a serious chronic disease associated with hyperglycemia, overweight, and metabolic syndrome. The prevalence of this disease is constantly increasing. This study aimed to investigate the separate and combined effects of resistance training and cucumber juice consumption on liver indicators in women with T2DM.

Methods: Females aged 35-70 years (N = 40) suffering from T2DM were selected. The subjects were randomly assigned to four groups (three experimental groups and one control group). The Training+ placebo group implemented resistance training and consumed a placebo. The Training+ Supplement group implemented resistance training and consumed cucumber juice, the Supplement group consumed cucumber juice, while the control group consumed a placebo for eight weeks. 48 hours before and after the research, blood sampling was done, and changes in liver enzyme levels were investigated and compared among the groups. Data were analyzed using one-way analysis of variance (ANOVA) and Tukey's post-hoc test at a significance level of $p \leq 0.05$.

Results: The results of the present study showed that eight weeks of separate or combined resistance training and consumption of cucumber juice led to a significant reduction in the levels of liver enzymes Alanine transaminase (ALT), Aspartate transaminase (AST), and Alkaline phosphatase (ALP) ($p \leq 0.05$).

Conclusion: In the present study, liver enzyme levels decreased. Therefore, separate or combined implementation of resistance training and consumption of cucumber juice can be used as therapeutic aids to control the levels of liver enzymes in women with T2DM.

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Introduction

One of the most common types of diabetes, which accounts for more than 90% of all cases of diabetes, is type 2 diabetes mellitus (T2DM) (1). This is a serious illness that is related to hyperglycemia, overweight, and metabolic syndrome. The prevalence of T2DM is constantly increasing. Sedentary lifestyle and overweight have been identified as key risk factors for T2DM (2). This disease is associated with hyperglycemia, insulin resistance, and a relative insulin deficiency with a gradual onset. T2DM is a silent disease that affects different organs of the body. The liver is one of the organs most strongly affected by T2DM (3). In fact, the liver is directly affected by T2DM and indirectly through reactive oxygen species and oxidative stress. The liver plays an important role in the lipid transport and metabolism and probably participates in the occurrence and development of diseases such as atherosclerosis, T2DM, and obesity (4). Maintaining the stability of the blood glucose level by harvesting and storing glucose in the form of glycogen, glycogenesis, glycogenolysis, and gluconeogenesis processes is one of the functions of the liver (5). In fact, one of the organs of the body that helps maintain blood sugar within the normal range is the liver. An increase in blood sugar leads to an imbalance of oxidation-reduction reactions in liver cells. Among the predictors of diabetes, an increase in liver enzyme levels can be considered a predictor (6). Diabetes increases liver enzyme levels in the blood, mainly due to increased oxidative stress in liver tissues. In fact, the plasma concentration of liver enzymes is the best indicator to evaluate the condition of the liver, and it is one of the indicators through which one can find out the presence of diabetes in a person (7). Cucumber has antioxidant activity and can possibly help in the treatment of liver disease (8). Ezodili et al. (2017) showed that cucumber consumption does not cause significant changes in the levels of liver enzymes (Aspartate aminotransferase and alanine aminotransferase) (4). However, exercise training leads to significant changes in the levels of liver enzymes. Researchers have reported that eight weeks of resistance training led to a decrease in plasma levels of liver enzymes Alanine transaminase (ALT) and Aspartate transaminase (AST), in men with non-alcoholic fatty liver disease (9,10). Although regular physical activity may play a role in controlling diabetes and its complications, including fatty liver, most people with T2DM are inactive. On the other hand, despite the importance of sports activity in improving the conditions of diabetes, there are many discussions about prescribing exercise programs along with the effect of supplement consumption on the health of these people. In recent decades, exercise combined with dietary interventions has been recommended as an effective approach for the management of diabetes. Considering the high costs of medications used to treat T2DM and the side effects caused by their use, we sought to see whether we can help diabetic patients by combining exercise and diet. To the best of our knowledge, there are no data on the effects of resistance training and cucumber juice consumption on the liver enzyme levels in women with T2DM, and this issue should be comprehensively investigated. Therefore, this study aimed to assess the effects of resistance training and the consumption of cucumber juice on the liver enzymes status of women with T2DM.

Methods

Study design

This trial utilized a randomized, double-blind, pretest-posttest design and focused on women with T2DM who were referred to the

Kermanshah Diabetes Research Center. The inclusion criteria for the research focused on females aged 35-70 with T2DM who had a valid COVID-19 vaccination card, fasting blood sugar levels between 140 and 280 mg/dl, no regular physical activity during the past six months, and a health certificate from a physician allowing them to participate in sports activities. Conversely, participants were excluded if they voluntarily withdrew from the study, sustained an acute injury during resistance exercises, or missed two consecutive sessions or three nonconsecutive sessions during the research period.

A total of 40 women with T2DM were selected for the study. Subjects were randomly placed into four groups (Three experimental groups and one control group). Each group consisted of 10 participants. This research lasted for eight weeks (24 sessions). Anthropometric measurements of the subjects were done by the researcher before the trial and are shown in Table 1. Before and after each session, a glucometer was used to measure the blood sugar levels of the subjects. It should be noted that none of the subjects were under insulin therapy.

Supplementation protocol

This trial was double-blind. The placebo was prepared to be similar in color and taste to cucumber juice (C. sativus L.). Subjects were unaware of whether they received cucumber juice or placebo. In addition, the researcher did not know about this process. The research assistant administered cucumber juice to the (Training+Supplement and Supplement) groups, and a placebo to the (Training+Placebo and control) groups in a double-blind manner. The research assistant ensured that each participant consumed the full 240 mL portion.

Resistance training protocol

This protocol was implemented in the gym. Participants were tested for one-repetition maximum (1RM) to determine muscle strength. The resistance training program consisted of 40-minute sessions (Three times per week for 8 weeks). Each exercise consisted of 2 sets with 8-10 repetitions. The rest between sets was 2 minutes. Training intensity ranged from 60% to 75% of 1RM.

Laboratory assessments

Blood samples were collected 48 hours before and after the intervention, and the changes in liver enzyme levels were investigated and compared among the groups. Blood samples (7 ml) were collected from the antecubital vein by a laboratory specialist 48 hours before and after the trial. Liver indicators (ALT, AST, and Alkaline phosphatase (ALP)) were investigated before and after the trial in the four groups. Liver enzyme levels are shown in Table 2.

Statistical analysis

All data were analyzed using SPSS version 22.0. One-way analysis of variance (ANOVA) and Tukey's post-hoc test were used for data analysis, with a significance level of $p \leq 0.05$.

Results

Anthropometric measurements are shown in Table 1. The liver enzymes (ALT, AST, and ALP) showed a significant reduction from the pre-test stage to the post-test stage ($p < 0.05$) in all three experimental groups (Training + placebo, training + supplement, and supplement). The pre-test to the post-test showed no significant changes in any variables in the control group ($p \geq 0.05$). The liver enzymes (ALT, AST, and ALP) were significantly decreased after eight weeks of resistance training ($p < 0.05$). Additionally, the enzymes were significantly reduced after eight weeks of cucumber juice consumption ($p < 0.05$). Combined resistance training and cucumber juice consumption reduced liver enzymes (ALT, AST, and ALP) significantly ($p \leq 0.05$). The results of the one-way ANOVA test indicated a significant difference in the changes in the levels of liver enzymes (ALT, AST, and ALP) among the Training+ placebo, Training+ supplement, and supplement and control groups ($p=0.0001$).

Tukey's post-hoc test showed significant differences between training + placebo and training + supplement groups, training + placebo and supplement groups, and supplement and control groups, training + placebo and control groups, training + supplement and control groups in the levels of liver enzymes (ALT and ALP). Also, there was a significant difference in the levels of liver enzymes (ALT and ALP) in the supplement and training+ supplement groups ($p \leq 0.05$). The test showed a significant difference in AST levels between the training + placebo and training + supplement groups, training + placebo and control groups, training + supplement and supplement groups, and training + supplement and control groups ($p \leq 0.05$). There were no significant differences in the levels of AST between training+ placebo and supplement groups and supplement and control groups ($p \geq 0.05$).

Table 1. Demographic characteristics of the study

Group	Age (Yr)	Weight (kg)	Height (m)	BMI (kg/m^2)
Training+Placebo	49.30±4.64	76±12.82	1.58±0.04	30.50±5.66
Training+Supplement	48.90±4.30	77.08±9.94	1.56±0.04	31.69±3.76
Supplement	49.50±4.30	80.12±10.48	1.55±0.04	33.23±5.73
Control	49.40±4.35	82.67±10.53	1.57±0.04	33.35±4.86

BMI: Body Mass Index

Table 2. The liver enzymes levels before and after the study

Groups \ Variable	ALT (U/L)		AST (U/L)		ALP (U/L)	
	Before	After	Before	After	Before	After
Training+Placebo	37.70±5.22	31.10±5.42	32.30±3.83	26±3.80	179.60±52.10	111.60±36.18
Training+Supplement	42.90±7.53	29.70±6.21	47.90±9.63	27.50±5.19	243±31.51	127±27.74
Supplement	29.40±5.31	26.60±4.99	33.40±6.85	30±6.49	170.10±37.66	135.70±36.67
Control	28.40±7.01	28.60±7.01	25.50±4.14	25.70±4.11	147.80±23.03	148.10±23.34

ALT: Alanine Transaminase ; AST: Aspartate Transaminase ; ALP: Alkaline Phosphatase

Discussion

The research carried out in the field of the effects of cucumber consumption on the levels of liver enzymes is limited. Ezodili et al. (2017) showed that 21 days of consuming 400 grams of cucumber in the fasting state did not result in a significant change in aspartate transaminase and alanine transaminase levels compared with the pre-test state in healthy undergraduate students (4). The results of their research are not consistent with the present study. Mohammad et al. (2021) evaluated the effect of aqueous extract of cucumber fruit on liver enzymes (Aspartate transaminase and alanine transaminase) in healthy rats and rats induced with diabetes by streptozotocin. The results of their research showed that this extract has no toxic effect and leads to the reduction of AST and ALP levels and may be used to manage the treatment of diabetes (11). Egbirmahon et al. (2022) investigated the comparative effect of cucumber leaves and juice on the liver of albino rats. Their findings showed that cucumber leaf and juice extracts are safe and non-toxic to the liver (12).

Cucumber juice is rich in antioxidants, vitamins, minerals, and other bioactive compounds. One of these compounds is cucurbitacin. Cucumber bitterness is mainly caused by cucurbitacin C, but in very small amounts (Much less than 1 mg/100 g) (13). Cucurbitacins have been shown to have anti-inflammatory and hepatoprotective properties. When ingested, these compounds can trigger a series of cellular and molecular events in the liver. Studies have shown that cucurbitacin inhibits the activity of certain liver enzymes involved in the metabolism of toxins and drugs, such as cytochrome P450 enzymes. By inhibiting these enzymes, cucumber juice may improve liver detoxification processes, reduce liver workload, and modulate liver enzyme activity. In addition, cucumber juice is a diuretic, and by increasing urine production and helping eliminate toxins from the body, it can indirectly affect liver enzymes by reducing exposure to harmful substances. The mechanism of the hepatoprotective effect of cucumber can be due to the reduction of the production of reactive oxygen species and antioxidant properties (14). At the cellular level, antioxidants in cucumber juice, such as vitamin C and beta-carotene, can scavenge free radicals and reduce oxidative stress. It helps protect liver cells from damage and maintains their normal function. Oxidative stress is known to release liver enzymes into the bloodstream. With vitamins such as vitamin C and beta-carotene, cucumber reduces oxidative stress, increases the total antioxidant capacity, and consequently reduces the levels of liver enzymes (AST, ALT, and ALP) (7). At the molecular level, cucumber juice may also affect the expression of liver enzymes. Research shows that cucurbitacin can modulate gene expression, specifically targeting genes involved in inflammation and liver function. By downregulating pro-inflammatory genes and upregulating anti-inflammatory genes, cucumber juice may help reduce liver inflammation and improve liver enzyme levels. In addition, the protective function of the liver has been confirmed due to the presence of saponarin in the cucumber (15). Physical activity intensifies liver enzyme activity (16). High-intensity prolonged training has a significant effect on the activity of liver enzymes (17). Ruiz et al. (2014) concluded that moderate-to-vigorous physical activity leads to a significant increase in AST and the AST/ALT ratio (18). These researchers concluded that training intensity is an effective factor in creating significant changes in the activity of liver enzymes. Therefore, the intensity of training, both aerobic and resistance, as the most important component of training, can have positive or negative effects on body tissues. Therefore, the correct design of training intensity can increase the function of different body tissues, including the liver tissue. It has been suggested that physical activity and lifestyle interventions help reduce liver fat, enhance liver enzyme activity, improve blood supply to liver tissue, and optimize lipid metabolism in the liver (19). Some studies have concluded that individuals who engage in regular physical activity have lower levels of ALT, AST, and gamma-glutamyl transferase (20).

Long-term endurance activities, which predominantly rely on aerobic metabolism, affect the activity of AST and ALT enzymes due to the increased demand for energy production through the aerobic system. Since AST and ALT are key enzymes in liver metabolism, and the liver contributes more significantly during endurance exercise, the risk of liver cell membrane damage is higher in such activities. In contrast, heavy resistance training primarily depends on anaerobic pathways for energy supply; thus, liver cells and their enzymes are less involved, resulting in a lower likelihood of enzyme-related damage (21). Therefore, resistance training is considered the best type of training for women with T2DM who have high levels of liver enzymes ALT, AST, and ALP.

Conclusion

Integrating resistance training with cucumber juice consumption presents a promising non-pharmacological strategy for managing T2DM in women, which effectively reduces liver enzyme levels, while offering a cost-effective and natural alternative to traditional medications. This dual approach not only enhances physical health but also empowers women to take control of their diabetes management.

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Ethical statement

This study was approved by the Ethics Committee in Biomedical Research at Razi University, Kermanshah, Iran (Code: IR.RAZI.REC.1400.092).

Conflicts of interest

There are no conflicts of interest to declare by any of the authors.

Author contributions

ML and NB analyzed and interpreted the patient data. ML performed this project and was a major contributor to writing the manuscript. NB checked the prepared manuscript. All authors read and approved the final manuscript.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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