



# The role of natural supplement of apple vinegar and syrup in the management of type 2 diabetes mellitus

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## ABSTRACT

**Introduction:** The increased risk of coronary artery disease in diabetics could be explained by the lipoprotein irregularities associated with diabetes mellitus. The primary aim of this study is to examine the role of apple vinegar and syrup in the management of type 2 diabetes mellitus.

**Methods:** The interventional study included 500 participants (195 men and 305 women) with dyslipidemia and prediabetes or type 2 diabetes mellitus, aged 50-70 years, living in Sarajevo area. Patients were recruited from 5 outpatient diabetes counselling departments and treated with natural apple vinegar and syrup supplementation over a period of five weeks. The patients have been evaluated before treatment and 5 weeks after the treatment. During the study, dosage of drugs for diabetes or prediabetes was not changed.

**Results:** After 5 weeks of supplementation with apple vinegar and syrup waist circumference ( $p=0.016$ ), total cholesterol ( $p=0.01$ ), low density lipoprotein (LDL) cholesterol ( $p=0.008$ ) and triglycerides ( $p=0.019$ ) were significantly reduced, as well as blood pressure (-14%). Study results show decrease of mean fasting blood levels of glucose, but statistically not significant ( $p=0.058$ ). The body mass index also decreased insignificantly ( $p=0.089$ ). The high density lipoprotein cholesterol level was not increased significantly after supplementation ( $p=0.26$ ).

**Conclusion:** According to our results, apple vinegar has important role in reduction of total cholesterol levels, triglycerides, LDL cholesterol and waist circumference in patients with type 2 diabetes. Also, it has positive effect on blood pressure.

**Keywords:** Natural products; apple vinegar; dyslipidemia; type 2 diabetes mellitus

## INTRODUCTION

Coronary artery disease is the most common cause of death in patients with diabetes. The increased risk of coronary artery disease in diabetics could be explained by the lipoprotein irregularities associated with diabetes mellitus (1). The most common lipid

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abnormalities in diabetics are hypertriglyceridemia and low levels of high-density lipoprotein (HDL). In type 1 diabetes mellitus, these abnormalities can usually be reversed with glycemic control. In type 2 diabetes mellitus (T2DM), although lipid values improve, abnormalities commonly persist even after optimal glycemic control has been achieved (1). The lipoprotein abnormalities are related to the severity of the insulin resistance. A study that measured insulin sensitivity using euglycemic clamp in patients with and without T2DM found that greater insulin resistance was associated with larger very low density lipoprotein (VLDL) particle size, smaller low density lipoprotein (LDL) particle size, and smaller HDL particle size (2).

Annual screening for dyslipidemia is recommended in patients with diabetes mellitus. Such screening should include measurements of total cholesterol, HDL, low-density lipoprotein (LDL) and triglyceride levels. An acceptable LDL level is less than 3.35 mmol/l; triglycerides should be less than 2.25 mmol/l. In patients with clinically evident vascular disease, LDL levels should be less than 2.60 mmol/l, and triglycerides should be less than 1.70 mmol/l. Whether these lower values should be the target for all patients with diabetes, regardless of whether they manifest vascular disease, has been a matter of debate. An HDL level greater than 1.15 mmol/l is recommended (3).

Primary lines to lowering the levels of lipids in subjects with diabetes mellitus should include glycemic control, diet, exercises and weight loss. If the goals for lipid levels have not been reached after 3 to 6 months of diet, exercise and improved glycemic control including drug therapy should be started (4). Effective treatment includes a combination of pharmacologic and non-pharmacologic therapy.

Currently, the accessibility of multiple lipid-lowering drugs and supplements make available new opportunities for patients to succeed target lipid levels. However, the variety of therapeutic options poses a challenge in the ordering of drug therapy. Most people with diabetes mellitus are candidates for statin therapy, and often need treatment with multiple agents to achieve therapeutic goals. Nevertheless, drug therapy for dyslipidemia must be personalized (5).

For more than 2000 years, vinegar has been used to flavor and preserve foods, heal wounds, clean surfaces, fight infections, and manage diabetes. However, many recent studies have reported that vinegar reduces the glucose answer to a carbohydrate load in healthy adults and in people with diabetes (6). Vinegar can be made from practically any fermentable carbohydrate source, as well as wine, apples, molasses, dates, pears, coconut, grapes, melons, honey, beer, maple syrup, potatoes, beets, grains. Vinegar's use can be considered safe by default. Yet there are rare reports about adverse reactions to vinegar ingestion (6).

The effect of vinegar on glucose was first reported by Ebihara and Nakajima (7) in 1988. In healthy adults, the insulin response was reduced for 20% after the ingestion of 50 g sucrose in combination with 60 mL strawberry vinegar (7). Several years later, Brighenti and colleagues (8) demonstrated that 20 mL white vinegar as a salad dressing ingredient reduces the glycemic answer by over 30% in healthy people ( $p < 0.05$ ). As well, additional placebo-controlled studies have documented antiglycemic effects of 20 g vinegar in healthy adults (9,10).

Apple vinegar might help lower blood sugar levels in people with diabetes by changing how foods get absorbed from the gut (11). In the past decade, there has been an increase in the use of natural products in type 2 diabetes mellitus (12). According to our knowledge, few studies have been done with apple vinegar in people with diabetes mellitus. Therefore, we designed pilot study, first in our country to investigate the effect of apple vinegar and syrup by brand product called Cardio Fit in participants with diabetes. The aim of this study was to examine the role of apple vinegar and syrup supplements in the management of type 2 diabetes mellitus.

## METHODS

### Study design

The interventional study included 500 participants (195 men and 305 women) with dyslipidemia and prediabetes or type 2 diabetes mellitus, age 50-70 years, living in Sarajevo area. Patients were recruited from April to July 2013, from five different outpatient diabetes counselling departments.

The inclusion criteria were: participants with dyslipidemia and prediabetes or T2DM according

to ADA criteria (13) on oral antidiabetic therapy. Patients with prediabetes used metformin, whereas patients with diabetes used metformin or combination of metformin and sulfonil-urea products. Total of 29% of the patients have never used statins for treatment of dyslipidemia, and 71% of patients have been using them occasionally, but ceased the usage during the study. Most of the participants had T2DM (n=485), while the number of subjects with prediabetes was 15 (3%) which is statistically insignificant, so that the subjects were not divided into two groups. The exclusion criteria were: alcohol consumption, liver diseases, chronic renal failure and hypothyroidism.

The patients were treated with natural apple vinegar supplementation (Cardio Fit, BioBrand, Bosnia and Herzegovina) over a period of five weeks. The patients have been thoroughly evaluated before treatment, and 5 weeks after the treatment. The study was performed according to the principles outlined in the Declaration of Helsinki and in accordance with ethical recommendations of the local Ethics Committee. The study was approved by the Ethics committee of the Medical Chamber.

Before and after the treatment, all the patients were measured fasting blood levels of glucose (FBG), total cholesterol, triglyceride, LDL-C (low density lipoprotein cholesterol), HDL-C (high density lipoprotein cholesterol), AST (aspartate transaminase), ALT (alanine transaminase), creatinine, blood pressure, ECG, waist circumference and body mass index (BMI). Glycosylated hemoglobin (HbA1c) was measured only at the beginning because the short period since the last measurement. BMI was calculated as weight in kilograms divided by the square of height in meters ( $\text{kg}/\text{m}^2$ ). During the study, dosage of drugs for diabetes or prediabetes was not changed. All patients with prediabetes were taking metformin, whereas 33% of diabetics were taking only metformin and 67% diabetics were taking combination of oral antidiabetics: metformin and glimepiride or glibenclamide.

The patients were familiarized with the usage of Apple vinegar and syrup preparation and received the complete dosage. Each patient was taking 40 ml of apple syrup and 20 ml apple vinegar, daily. Doses are standardized by using plastic cups that were included in the supplement package.

Four patients experienced side effects related to their gastrointestinal tracts (vomiting and nausea) and decided against further consumption of the preparation (0.8%), eight patients had minor gastrointestinal difficulties and continued to consume half of the recommended dosage of the preparation for 3-5 days after which the difficulties ended and they continued using the full dosage of the preparation. Fourteen patients (2.8%) out of the total number of patients, did not show up for the control check-up after 5 weeks of consuming the preparation due to unknown reasons.

### Statistical analyses

Normal distribution was investigated using Shapiro-Wilk test. Data were expressed as means (SD) or absolute numbers (percentages) according to type of variables and normality of distributions. Statistical analysis of laboratory parameters was carried out by Student's T. The cut-off for statistical significance was 0.05.

## RESULTS

Clinical data of the patients included in the study are shown in Table 1.

The patients have been thoroughly evaluated before treatment, and 5 weeks after treatment with supplements. After 5 weeks of treatment with Apple vinegar and syrup the waist circumference ( $p=0.016$ ), total cholesterol ( $p=0.01$ ), LDL cholesterol ( $p=0.008$ ) and triglycerides ( $p=0.019$ ), significantly reduced as well as blood pressure (-14%). Reduction of waist circumference is shown in Figure 1, reduction of triglycerides is shown in Figure 2, while the effect of Apple vinegar and syrup on blood pressure is shown in Figure 3.

Study results show decrease of mean FBG, but statistically not significant ( $p=0.058$ ). The BMI also decreases insignificantly ( $p=0.089$ ). The HDL level was not significantly elevated after the supplementation ( $p=0.26$ ).

## DISCUSSION

Many studies have investigated the antiglycemic and antilipidemic effects of natural products in diabetes mellitus. Some of them have proved the positive

**TABLE 1.** Clinical and laboratory characteristics of the study population

Parameters	Descriptive statistics		T	P
	Before treatment	After 5 weeks of treatment		
*Number n (%)	500 (100)	486 (97,2)		
*Age (y)	59.89±9.9	58.45±7,6		
*Sex M/F (n/%)	195/305 (39/61)	195/291 (40/60)		
*Blood pressure (mmHg)	150/90	130/80 (-14%)		
*HbA1c (%)	8,64±1,77			
*BMI (kg/m <sup>2</sup> )	29.43±1.41	26.95±1.12	1.7	0.089
*Waist (cm)	102.65±6.36	95.47±3.54	2.4	0.016
*FBG (mmol/l)	6.36±2.11	5.91±1.72	1.9	0.058
*Total Cholesterol (mmol/l)	6.95±0.99	6.49±0.35	2.56	0.010
*HDL (mmol/l)	1.05±0.47	1.11±0.21	1.11	0.260
*LDL (mmol/l)	3.75±2.22	3.27±0.95	2.64	0.008
*Triglycerides (mmol/l)	3.71±0.67	2.17±0.77	2.35	0.019

Data in descriptive statistics were expressed as \*means (SD) and, \*absolute numbers (%). Laboratory parameters were analyzed by Student's T test for paired samples (T). P=significance

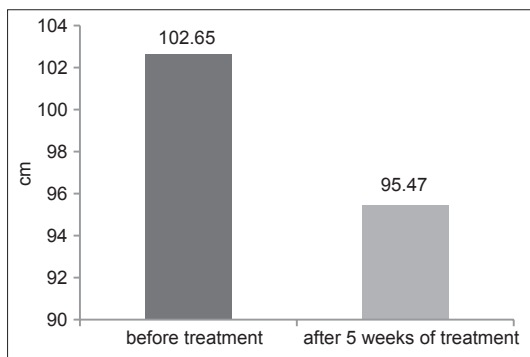
effect of these natural products on lipid and glucose level in diabetics (14-16).

On the other hand, based on the published information, there is little evidence to support the use of herbal products for the treatment of T2DM. Some agents may be useful as adjunctive therapy (12).

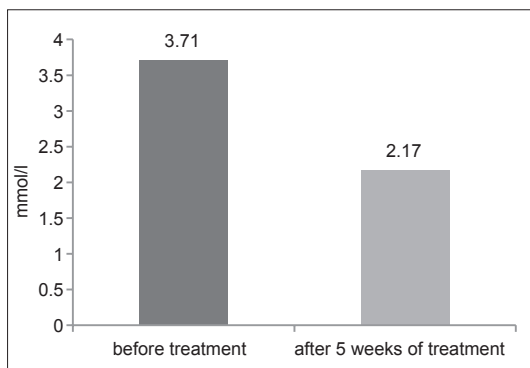
This research examines the scientific evidence for uses of apple vinegar, focusing particularly on the recent investigations supporting vinegar's role as antilipidemic agent. The hypoglycemic and hypolipidemic properties have been reported for vinegar, but some cases of discrepant effects were also observed. Mahmodi et al. showed hypoglycaemic effect of apple vinegar (17).

In comparison with these results, the effectiveness of Apple vinegar and syrup on glycemc control in our study was not significantly registered. Partial explanation for this difference could be the short duration of the study.

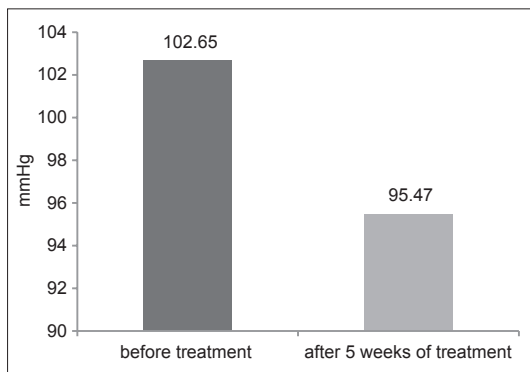
According to our results, it is important to emphasize the influence of Apple vinegar and syrup on a significant reduction of total cholesterol levels, triglycerides and LDL cholesterol. Mahmoodi et al.



**FIGURE 1.** The effects of apple vinegar and syrup on waist circumference in patients with type 2 diabetes mellitus (p=0.016)



**FIGURE 2.** The effects of apple vinegar and syrup on triglycerides in patients with type 2 diabetes mellitus (p=0.019)



**FIGURE 3.** The effects of apple vinegar and syrup on blood pressure in patients with type 2 diabetes mellitus (p<0.05)

did not find lipid changes in diabetics after vinegar supplementation (17).

Also, it is necessary to emphasize the reduction of BMI and a pronounced reduction in waist

circumference, which show a statistically significant reduction. This reduction of visceral fat can be explained by an adequate response of insulin after meal, which is shown in study of Ostman et al (18). A significant reduction of 14% in blood pressure was registered in comparison to prior registered values of all patients. Kondo and colleagues (19) reported a significant reduction in systolic blood pressure. These observed reductions in systolic blood pressure were associated with reductions in both plasma renin activity and plasma aldosterone concentrations reductions in renin activity and aldosterone concentrations.

Apple vinegar preparation did not have any reported harmful metabolic effects apart from (0.8%) insignificant gastrointestinal difficulties in 4 patients for which we are unsure whether they were other coincidental gastrointestinal and alimentary disorders. Inflammation of the oropharynx and second-degree caustic injury of the oesophagus after vinegar consumption occur rarely (20).

Future investigations are needed to delineate the mechanism by which apple vinegar alters lipids and glucose metabolism, especially in subjects with diabetes mellitus. Furthermore, future controlled studies need to follow-up patients over a longer period of time.

## CONCLUSION

According to our results, apple vinegar has important role in reduction of total cholesterol levels, triglycerides, LDL cholesterol and waist circumference in patients with type 2 diabetes. Also, it has positive effect on blood pressure.

## COMPETING INTERESTS

The authors declare that they have no competing interests.

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## REFERENCES

- O'Brien T, Nguyen TT, Zimmerman BR. Hyperlipidemia and Diabetes Mellitus. *Mayo Clinic Proceedings*, 1998;73(10),969–976. <http://dx.doi.org/10.4065/73.10.969>.

- Garvey WT, Kwon S, Zheng D, Shaughnessy S, Wallace P, Hutto A, et al. Effects of insulin resistance and type 2 diabetes on lipoprotein subclass particle size and concentration determined by nuclear magnetic resonance. *Diabetes* 2003;52:453. <http://dx.doi.org/10.2337/diabetes.52.2.453>.
- AACE Lipid and Atherosclerosis Guidelines. *Endocr Pract*. 2012;18(suppl 1).
- American Diabetes Association. Standards of Medical Care in Diabetes—2013. *Diabetes Care*, 2013; 36, S4-S10. <http://dx.doi.org/10.2337/dc13-S004>.
- Mooradian AD. Dyslipidemia in type 2 diabetes mellitus. *Nat Clin Pract Endocrinol Metab*. 2009; 5(3):150-9. <http://dx.doi.org/10.1038/ncpendmet1066>.
- Johnston CS, Gaas CA. Vinegar: Medicinal Uses and Antiglycemic Effect. *MedGenMed*. 2006; 8(2): 61.
- Ebihara K, Nakajima A. Effect of acetic acid and vinegar on blood glucose and insulin responses to orally administered sucrose and starch. *Agric Biol Chem*. 1988;52:1311–1312. <http://dx.doi.org/10.1271/bbb1961.52.1311>.
- Brighenti F, Castellani G, Benini L, et al. Effect of neutralized and native vinegar on blood glucose and acetate responses to a mixed meal in healthy subjects. *Eur J Clin Nutr*. 1995;49:242–247.
- Johnston CS, Buller AJ. Vinegar and peanut products as complementary foods to reduce postprandial glycemia. *J Am Diet Assoc*. 2005;105:1939–1942. <http://dx.doi.org/10.1016/j.jada.2005.07.012>.
- Leeman M, Ostman E, Björck I. Vinegar dressing and cold storage of potatoes lowers postprandial glycaemic and insulinaemic responses in healthy subjects. *Eur J Clin Nutr*. 2005;59:1266–1271. <http://dx.doi.org/10.1038/sj.ejcn.1602238>.
- Web MD. Apple cider vinegar uses & effectiveness (cited 2014 Oct 18). Available from: <http://www.webmd.com/vitamins-supplements>.
- Mansukhani R, Volino L, Varghese R. Natural Products for the Treatment of Type 2 Diabetes Mellitus. *Pharmacology & Pharmacy*, 2014; 5, 487-503. <http://dx.doi.org/10.4236/pp.2014.55059>.
- American Diabetes Association. Standards of medical care in diabetes—2013. *Diabetes Care*. 2013; 36 (Suppl 1): S11-S66. <http://dx.doi.org/10.2337/dc13-S011>.
- Jung HL, Kang HY. Effects of Korean red ginseng supplementation on muscle glucose uptake in high-fat fed rats. *Chin J Nat Med*. 2013;11(5):494-9.
- Wang Q, Jiang C, Fang S, Wang J, Ji Y, Shang X, Ni Y, Yin Z, Zhang J. Antihyperglycemic, antihyperlipidemic and antioxidant effects of ethanol and aqueous extracts of *Cyclocarya paliurus* leaves in type 2 diabetic rats. *J Ethnopharmacol*. 2013;150(3):119-27. <http://dx.doi.org/10.1016/j.jep.2013.10.040>.
- Kianbakht S, Sabaghian FH. Improved glycemic control and lipid profile in hyperlipidemic type 2 diabetic patients consuming *Salvia officinalis* L. leaf extract: a randomized placebo. Controlled clinical trial. *Complement Ther Med*. 2013;21(5):441-6. <http://dx.doi.org/10.1016/j.ctim.2013.07.004>.
- Mahmoodi M, Hosseini-zjoud SM, Hassanshahi G, Nabati S, Modarresi M, Mehrabian M, et al. "The effect of white vinegar on some blood biochemical factors in type 2 diabetic patients." *Journal of Diabetes and Endocrinology*. 2013;4(1):1-5.
- Ostman E, Granfeldt Y, Persson L, Björck I. Vinegar supplementation lowers glucose and insulin responses and increases satiety after a bread meal in healthy subjects. *Eur J Clin Nutr*. 2005;59:983–988. <http://dx.doi.org/10.1038/sj.ejcn.1602197>
- Kondo S, Tayama K, Tsukamoto Y, Ikeda K, Yamori Y. Antihypertensive effects of acetic acid and vinegar on spontaneously hypertensive rats. *Biosci Biotechnol Biochem*. 2001;65:2690–2694. <http://dx.doi.org/10.1271/bbb.65.2690>.
- Chung CH. Corrosive oesophageal injury following vinegar ingestion. *Hong Kong Med J*. 2002;8:365–366.