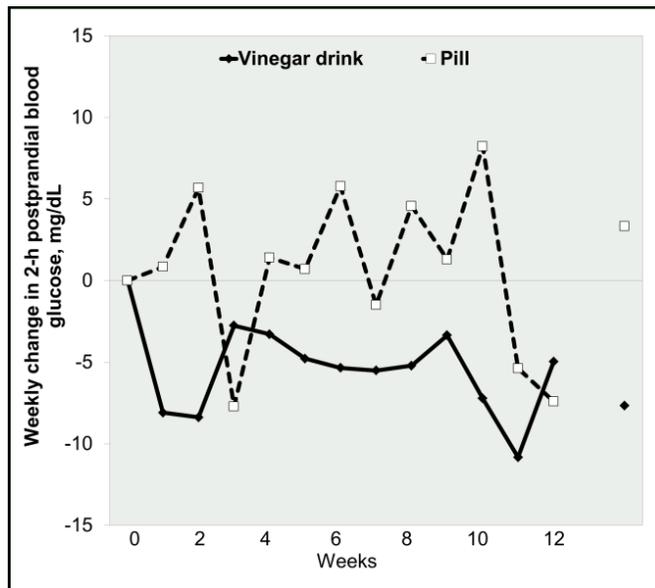
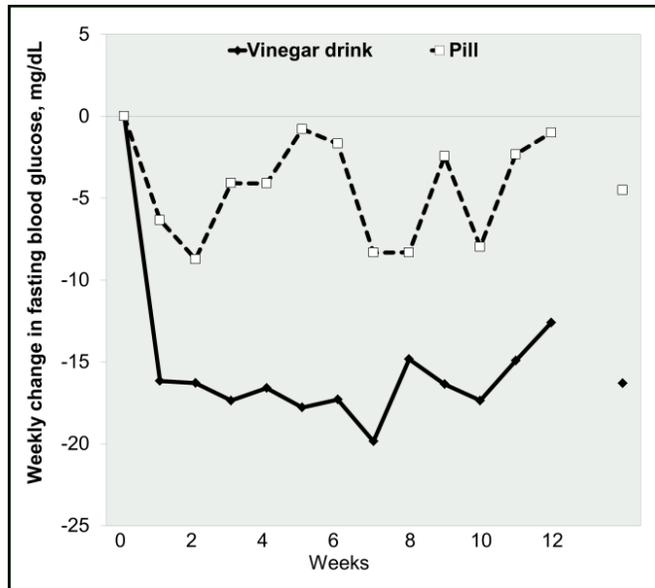


## ABSTRACT

Vinegar ingestion reduces postprandial glycemia and lowers hemoglobin A1c in individuals with type 2 diabetes (T2D); however, the long-term effect of vinegar in non-T2D is not known. This 12-week, randomized, parallel-arm trial examined the impact of vinegar ingestion on fasting and postprandial glucose in high-risk individuals (fasting glucose, 98.3±3.7 mg/dl; fasting insulin, 19.0±2.9 uU/ml). Of the 14 participants (13/1 F/M; 46.0±3.9 y; 28.5±1.4 kg/m<sup>2</sup>), 8 were diagnosed prediabetic but not prescribed hypoglycemic medications. Two daily treatments were followed: VIN [2 tablespoons vinegar or 1.5 g acetic acid] or CON [2 vinegar pills or 0.08 g acetic acid]. Treatments were taken as a divided dose immediately prior to the lunch and dinner meals daily. Fasting glucose and 2-h postprandial glucose concentrations were recorded daily using a glucometer. Reductions in fasting glucose were immediate and sustained for VIN vs. CON (average 12 week reduction: -16.3±4.9 and -4.5±3.2 mg/dl respectively, p=0.05). Controlling for prediabetes diagnosis did not impact these results. Average 12 week reductions in 2-h postprandial glucose did not vary significantly between groups (-7.7±6.9 vs. 3.3±5.4 mg/dl for VIN and CON respectively, p=0.259). These results support a therapeutic effect for vinegar in individuals at risk for T2D, including those diagnosed with prediabetes. (Funded by graduate college student award)

**INTRODUCTION** Vinegar ingestion at mealtime reduces postprandial glycemia and increases satiety, metabolic effects that may benefit individuals struggling with diabetes. 1-3 In a research summary, the American Diabetes Association states that 'Vinegar may make food healthier'. 4 As a result, the medicinal use of vinegar has likely increased in recent years. The main constituent of vinegar, acetic acid, is the active component in vinegar responsible for the improved glycemic responses to meal ingestion. Most vinegar research to date is acute trials spanning one to two meals. Furthermore, little is known regarding the long-term benefits of regular vinegar ingestion in healthy individuals at risk for developing diabetes. This 12-week study investigated the effect of daily vinegar ingestion on blood glucose concentrations in healthy individuals with elevated fasting glucose.

**METHODOLOGY** Healthy adults were recruited from a campus community. Volunteers were eligible for the trial if they were nonsmokers and free of chronic disease conditions including type 2 diabetes; volunteers with a diagnosis of prediabetes were not excluded. Stable prescription medication use was allowable, with the exception of any diabetic medication. Trial data are reported for the 14 completers: 7 vinegar and 7 control participants. All participants provided written informed consent, and the study was approved by the Arizona State University Institutional Review Board. The study treatments (vinegar drink or vinegar pill) were ingested twice daily with meals. The commercially available vinegar drink (Bragg Apple Cider Vinegar drink, Cinnamon, Calorie-free, Santa Barbara, CA) contained 1 tablespoon vinegar (750 mg acetic acid) per 8 oz. The commercially available vinegar pills (Apple Cider Vinegar tablets, General Nutrition Corporation, Pittsburgh, PA) contained 40 mg acetic acid per tablet. Participants were asked to maintain their usual diet and physical activity level throughout the 12-week trial, and to measure blood glucose twice daily: upon waking in a fasted state and at 2-h post-meal ingestion.



## RESULTS

Baseline characteristics did not differ between groups (Table 1). The average change in fasting glucose during the trial differed significantly between groups (-15.7±5.2 and -4.3±3.1 mg/dL for the vinegar and control groups respectively; p=0.029) (Figure 1). Figure 2 displays the mean 2-h postprandial glucose concentrations for each week of the study. The overall mean did not differ significantly between the vinegar drink (-7.6±6.8 mg/dL) and the vinegar pill group (3.3±5.3 mg/dL) (p=0.232)

## CONCLUSION

These data indicate that daily vinegar consumption favorably influences fasting glucose concentrations in healthy adults and contribute important information to the growing evidence base supporting the antiglycemic effects of vinegar. Vinegar is inexpensive, readily available, and a flavor enhancer. Although vinegar was taken as a drink prior to mealtime in the present study, vinegar can be incorporated into meals as a vinaigrette dressing on salads or vegetables or as a sandwich spread in the form of mustard, or it can simply be spritzed onto foods. Note that commercial vinegar tablets do not contain adequate amounts of acetic acid to induce an antiglycemic effect.

	Control (n=7)	Vinegar (n=7)	P
Gender, F/M	7/0	6/1	
Prediabetes diagnosis	3	5	
Age, y	48.1±5.2	43.9±6.2	0.607
Weight, lbs	167.7±13.6	168.9±16.4	0.954
BMI, kg/m <sup>2</sup>	29.2±2.2	27.7±2.0	0.614
Waist, in	35.8±2.2	36.3±2.3	0.869
Fasting glucose, mg/L	121.3±9.8	109.0±5.6	0.300
Fasting Insulin, mIU/mL	17.3±3.0	20.7±5.2	0.575
HbA1c, %	5.6±0.2	5.7±0.2	0.670

<sup>1</sup>P represents univariate analysis

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