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ORIGINAL ARTICLE

Effect of the Apple Cider Vinegar on Weight Management, Blood Glucose Levels and Lipid Profile among Obese/Overweight Adults: A Randomised Control Trial

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ABSTRACT

Objective: The objectives of this study are to evaluate the effect of apple cider vinegar on weight management, blood sugar level, HbA1C, and on lipid profile.
Design: It was a randomized control trial.
Study Settings: This study was conducted at OPD of Medicine, Hameed Latif Hospital.
Material and Methods: Two groups were formed, each with at least 30 participants. The first group of 30 obese/overweight patients received 15ml of ACV twice a day, before lunch and dinner (total dose of 30ml). The second group was the control group, which received 15ml of ACV twice daily before lunch and dinner (for a total dose of 30ml), but they were healthy and free of disease. The results of both interventional groups (pre and post interventional) in terms of lowering blood glucose and cholesterol levels, as well as body weight, were compared.
Results: Both the groups had 15 male and 15 female patients with age of obese and non-obese patients was 43 & 32.5 years respectively. Results showed reduction in weight of obese/overweight patients as compared to day 0 (34.35±6.07), day 30 (33.64±5.99) and day 60 (32.98±5.97), showing consistent reduction in BMI which reflected that increase in time of feeding ACV continued to decrease the body weight of obese/overweight patients.
Conclusion: In conclusion it was noted from the results that Apple Cider Vinegar has a positive effect n reducing HbA1c, cholesterol, triglycerides and BMI levels in the respective patients
Keywords: Apple Cider Vinegar, Weight, Blood Glucose Levels, Lipid Profile

INTRODUCTION

Diabetes is a fatal disease caused by disturbed carbohydrate metabolism along with protein and fat due to several reasons, main being the insulin resistance (John, 2016). It is the seventh global cause of mortality and morbidity (WHO,2018; CDC, 2020). The prevalence of this condition is presumably increasing due to sedentary life style leading to obesity (Sen, et al., 2019). It can affect heart, kidney, nerves and blood vessels which leads to impaired quality of life and eventually resulting in early death due to these complications (Liu, et al., 2010). t is also said to be the number one cause of kidney failure, lower limb amputations and adult blindness (CDC, 2020). Hyperlipidaemia is a growing problem worldwide causing other co health problems such as ischemic heart diseases, diabetes mellitus and cerebrovascular diseases. Deranged lipid profile can lead to obesity, atherosclerosis and hypertension (Ochuko, et al., 2011). Studies suggest that apple cider vinegar can decrease hyperlipidaemia by lowering the blood cholesterol, triglycerides, LDL and VLDL levels while significantly increasing the HDL levels (Ajaykumar, et al., 2012). The 2016 Global Statistics show an alarmingly high rate of 1.9 billion adults aged 18 years as overweight. 340 million children and young adults between the ages of 5 and 19 were shown to be either overweight or obese in the same year, i.e., 2016 by Global Statistics (WHO, 2016). The risk of overweight children to become obese in their later life is higher, as well as premature death and disability are more likely to occur (Gabriella, 2019). Apple cider vinegar is widely consumed in salad dressings, marinades, food preservatives, chutneys and other foods. Several studies have proven the pharmacological effects of apple cider vinegar including anti diabetic (Shishehbor, et al., 2008), antioxidant (Yang, et al., 2010, Denis, et al., 2013), and cholesterol lowering properties (Budak, et al., 2011), without adverse effects. It delays the gastric emptying and enteral absorption along with an increase in the utilization of glucose and suppresses the production of hepatic glucose. The effects of apple cider vinegar also include facilitation of insulin secretion, increase in lipolysis and decrease in lipogenesis. It enhances the energy usage and increases satiety thus helping in weight loss (Petsiou, et al., 2014). The anti-glycaemic effects might be due to delayed gastric emptying (Hlebowicz, et al., 2007), improved insulin sensitivity (Ogawa, et al., 2000), inhibited disaccharidase activity (Sakakibara, et al., 2006), or increased production of glycogen (Fushimi, et al., 2005). The objectives of this study are to evaluate the effect of apple cider vinegar on weight management, blood sugar level, $HbA1_C$, and on lipid profile.

MATERIALS AND METHODS

Study Design: This study was conducted as a randomized control trial
Study Locale: Data was collected from the patients arriving at OPD of Medicine in Hameed Latif Hospital for their treatment
Study Population: The target population were both male and females of ages ranging between 18-60 years. 15 males and 15 females were included in each group. The study population consisted of those participants who were diagnosed with type2 diabetes mellitus, hyperlipidaemia and obesity
Duration of Study: The interventional study was completed in a timeline of 2 months period
Exclusion Criteria:
1 Age above 60 or below 18 years
2 Patients who were suffering from diseases other than type2 diabetes, hyperlipidaemia or obesity/overweight
3 Patients who had not signed the consent for participating
Sampling Technique: Convenient sampling technique was used
Sample Size: A total of 60 patients was taken. Sample size was calculated using
Study Protocol: In our study, 30 obese/overweight patients were randomly selected from the OPD department of Medicine at Hameed Latif Hospital, as were 30 participants who were neither obese/overweight nor had any disease. Two groups were formed, each with at least 30 participants. The first group of 30 obese/overweight patients received 15ml of ACV twice a day, before lunch and dinner (total dose of 30ml). The second group was the control group, which received 15ml of ACV twice daily before lunch and dinner (for a total dose of 30ml), but they were healthy and free of disease. After a 12-hour fast, participants were given an HbA1c and lipid profile test. Their blood was drawn by a qualified phlebotomist from a reputable laboratory. After securing

the vein with a tourniquet, the skin was disinfected with a 70% isopropyl alcohol swab, and 2.5cc of blood was drawn with a 3cc syringe and stored in an ETDA vial under aseptic conditions. Participants had their initial HbA1c and lipid profile blood tests done at day 0 and then again at day 30 and day 60 after the start of the intervention, by the relative hospital lab. Weight analysis was done with the help of anthropometric measurements. The height and weight of the subjects were taken at the time of data collection and then at 30 and 60 days. Stadiometer and weight scale were used. The results of both interventional groups (pre and post interventional) in terms of lowering blood glucose and cholesterol levels, as well as body weight, were compared.

Ethical Approval: Ethical approval was taken from the Institutional Review Board (IRB) of NIU Lahore

Data Analysis: SPSS version 22 and ANOVA were used to analyse the data collected. Accordingly, frequency and percentages were gathered. In addition, the chi square and t-test were used to determine whether the results were statistically significant.

RESULTS

A total of 60 patients were included in this study. Patients were divided into two groups i.e. Group A and B. Both the groups received 30 ml of ACV daily. All the patients were between 18 – 60 years of age. Out of which 30 patients were obese/overweight and other 30 were neither obese/overweight nor did they have any disease. Both the groups had 15 male and 15 female patients (Table 1.1).The mean age of obese and non-obese patients was 43 & 32.5 years respectively (Table 1.2).

Table 1.1: The mean age of obese/overweight patients in both groups

Groups (n=30 each group)	Mean age (yr.)	Standard Deviations	P-value
Group A (ACV 30ml/day)	43.03	10.620	0.000
Group B (ACV 30ml/day)	32.43	7.637	

Table 1.2: Gender distribution between groups A and B

Gender	Groups (n=30 each group)		P-value
	GROUP A (30ml)	GROUP B (30ml)	
Male	15	15	0.000
FEMALE	15	15	
TOTAL	30(50%)	30(50%)	

Table 1.3: BMI (kg/m^2) on day 0, day 30 and day 60

Groups	BMI (kg/m^2) At day 0	BMI (kg/m^2) At day 30	BMI (kg/m^2) At day 60	P-value
Group A (ACV 30ml/day)	34.35±6.07	33.64 ± 5.99	32.98 ± 5.97	0.000
Group B (ACV 30ml/day)	21.62 ± 1.64	21.62 ± 1.64	21.62 ± 1.64	

Table 1.4: Cholesterol (mg/dl) on day 0, day 30 and day 60.

Groups	Cholesterol (mg/dl) At day 0	Cholesterol (mg/dl) At day 30	Cholesterol (mg/dl) At day 60	P-value
Group A (ACV 30ml/day)	202.23±19.76	187.77 ± 19.24	175.47 ± 19.35	0.000
Group B (ACV 30ml/day)	129.50 ± 10.69	129.50 ± 10.69	129.50 ± 10.69	

Table 1.3 shows the effect of ACV on BMI of the obese/overweight patients as compared to control group. Statistical analysis using independent t-test and nonparametric test,revealed significant (P=0.000,<0.01) reduction in weight of obese/overweight patients as compared to day 0 (34.35±6.07), day 30 (33.64±5.99) and day 60 (32.98±5.97), showing consistent reduction in BMI which reflected that increase in time of feeding ACV continued to decrease the body weight of obese/overweight patients.

Table 1.4 shows the effect of ACV on cholesterol levels of the obese/overweight patients as compared to control group, who were also treated with the same dosage. When the data was analysed in SPSS using independent t-test and nonparametric test, it exhibited significant (P=0.000 <0.01) reduction in cholesterol levels of obese/overweight patients when compared at day 0 (202.23 ± 19.76), day 30 (187.77 ± 19.24) and day 60 (175.47 ± 19.35). The effect of ACV on triglyceride levels (table 1.5), when both groups were given the same dose of ACV. When the data was statistically analysed using a nonparametric test, it revealed a significant (P0.000 0.01) reduction in triglycerides levels of obese/overweight patients as compared to day 0 (189.3±12.8), day 30 (177.6±12.6), and day 60 (165.8±13.0).Table 1.6 shows the effect of ACV on HbA1c levels of the obese/overweight patients as compared to control group. Data analysis revealed significant (P=0.000 <0.01) reduction in HbA1c levels of obese/overweight patients as compared on day 0 (9.13 ± 2.08), day 30 (7.98 ± 2.15) and day 60 (6.88 ± 2.05).

Table 1.5: Triglycerides (mg/dl) on day 0, day 30 and day 60

Groups	Triglyceride (mg/dl) At day 0	Triglyceride (mg/dl) At day 30	Triglyceride (mg/dl) At day 60	P-value
Group A (ACV 30ml/day)	189.30 ± 12.80	177.63 ± 12.66	165.80 ± 13.05	0.000
Group B (ACV 30ml/day)	126.77 ± 11.86	126.77±11.86	126.77±11.86	

Table 1.6: HbA1c (%) on day, day 30 and day 60

Groups	HbA1c (%) At day 0	HbA1c (%) At day 30	HbA1c (%) At day 60	P-value
Group A (ACV 30ml/day)	9.13 ± 2.08	7.98 ± 2.15	6.88 ± 2.05	0.000
Group B (ACV 30 ml/day)	5.34 ± 0.35	5.34±0.35	5.34±0.35	

DISCUSSION

Apple cider vinegar (ACV) is made from fermented apple juice, it is used for reducing cholesterol, regulating blood pressure, sore throats, to get rid of toxins, arthritis, osteoporosis, stimulate thinking and so on. Vinegar was thought to reduce postprandial glycemia (PPG) in healthy adults.

Apple Cider Vinegar & Diabetes Mellitus: Pusparatha, et al. did a study to see how ACV affected diabetic and obese people. They made a total of 10 diabetes patients (mean 140.6 + 2.13 mg/dl; range 105-156 mg/dl) aged 45-57 years and 10 obese patients (BMI 27.4 + 0.33 kg/m2; range 25-31.2 kg/m2) aged 18-59 years drink 20 ml ACV in 200 ml water every day before bed. This was done on a regular basis for 30 days. The BMI before and after consumption of ACV was 27.4 ± 0.33 and 26.9 ± 0.32, a significant decrease in BMI was observed. The diabetic patients had a decrease in blood glucose level from 140.6 ± 2.13 to 121.9 ± 2.28.For decreasing PPG, Johnston et al (2010) investigated vinegar dosage (10g vs. 20g), timing (during mealtime vs. 5 h before meal), and administration (acetic acid as vinegar vs. neutralised salt). PPG was significantly lowered by two tablespoons of vinegar (10 g), and this effect was most noticeable when vinegar was consumed during lunchtime rather than 5 hours before the meal. When tiny doses of vinegar were consumed with meals containing complex carbs, the anti-glycemic actions of vinegar became apparent. When compared to a placebo, vinegar reduced PPG by about 20% in these situations. Current study co-

related with the already published results, showing a significant decrease in blood sugar levels of diabetic patients at day 0 (215.2±59.78), day 30 (182.2±61.62) and day 60 (150.7±58.97). Thus, it was concluded that apple cider vinegar significantly reduced blood glucose levels in diabetic people.

Apple Cider Vinegar & Glycated Haemoglobin ($HbA1_C$): A pilot study was conducted to look into the long-term effects of acetic acid consumption. For 12 weeks, twice daily, 27 type 2 diabetic individuals were given either 1400mg or 700mg of acetic acid or a placebo pill containing 15mg acetic acid. HbA1c levels were found to be 0.16 percent lower in the group of patients who took the 1400mg pill after the indicated time period. As a result, the data suggested that consuming vinegar on a daily basis can help moderately with glycaemic control. It also aided in boosting the subjective satiety rate.

In 2014, a 12-week randomised clinical research was done to examine the effects of apple cider vinegar on the study and control groups. Both groups, totalling 44 obese people, were forced to follow a calorie-restricted diet with a daily energy deficit of 250 kcal. The participants were given 30 millilitres of vinegar per day, divided into 15 millilitre amounts at lunch and dinner. Both groups showed a statistically significant decrease in body fat and BMI, whereas the study group showed a statistically significant decrease in triglycerides, BMI, body weight, and hip girth when compared to the control group.

A 12-week study was conducted to see whether vinegar, vinegar pills, or pickles had an effect on HbA1c. Participants were randomly assigned to one of three groups: ACV, ACV tablets, or pickles. HbA1c levels in the vinegar group were lowered by 0.16 percent units, whereas HbA1c levels in the pill and pickle groups were slightly higher.

Johnston et al. conducted a randomised control experiment to see if ACV affected T2DM indicators in at-risk persons (prediabetics). A total of 14 prediabetics were split into two groups: control and ACV recipients. For 12 weeks, the interventional group was given one table spoon of ACV twice daily. A change was observed in fasting glucose levels, which were notably reduced in the vinegar versus control group.

Apple Cider Vinegar & Lipid Profile: An animal study was conducted to determine the effect of vinegar on the lipid profile. Following a few weeks of vinegar consumption with diet, the results showed a decrease in triglyceride and low-density lipoprotein cholesterol levels with an increase in high density lipoprotein levels.To determine the effect of ACV on blood lipid reduction, an interventional study was planned. For eight weeks, 19 patients with hyperlipidaemia were given 30ml of ACV twice daily. It significantly reduced total cholesterol, TG, and LDL levels while increasing HDL levels. Current study found reduction in triglycerides levels of obese/overweight patients compared on day 0 (189.3±12.8), day 30 (177.6±12.6) and day 60 (165.8±13.0), showing continuous reduction in triglycerides which described that increase in time of feeding ACV continued to decrease the triglycerides levels of obese/overweight patients.

Apple Cider Vinegar & Obesity/BMI: A double-blind study on the efficacy of vinegar on obesity was conducted in 155 obese Japanese. For 12 weeks, three groups were formed and each received a different dose, namely 30ml, 15ml, and 0ml. There was a significant reduction in body weight and serum triglycerides. In addition, both groups experienced a dose-dependent decrease in body fat mass, waist circumference, and body mass index during the first four weeks. Furthermore, the findings revealed that vinegar has no negative effects on human health.A randomised clinical trial was conducted in 2014 to compare the effects of apple cider vinegar on the study and control groups over a 12-week period. Both groups, totaling 44 obese people, were forced to follow a calorie-restricted diet with a daily energy deficit of 250 kilocalories. The study group received 30ml of vinegar per day, divided into 15ml portions at lunch and dinner. Both groups experienced a statistically significant decrease in body fat and BMI, while the study group experienced a statistically significant decrease in triglycerides, BMI, body weight, and hip girth when compared to the control group.Current study revealed significant **(P=0.000,<0.01)** reduction in weight of obese/overweight patients as compared to day 0 **(34.35±6.07)**, day 30 **(33.64±5.99)** and day 60 **(32.98±5.97)**.

CONCLUSION

In conclusion it was noted from the results that Apple Cider Vinegar has a positive effect n reducing HbA1c, cholesterol, triglycerides and BMI levels in the respective patients. Group A (n=30) was given 30 ml/day of apple cider vinegar, which showed significant reduction in the levels (p<0.001) of HbA1c, cholesterol, triglycerides and BMI. Whereas group B (n=30) was also given 30ml/day of apple cider vinegar but showed no significant results. Different studies also suggested similar results. There was a visible reduction in levels of HbA1c, cholesterol, triglycerides and BMI of the patients on 3oth and 60th day. Apple cider vinegar has proved to decrease the progression of HbA1c, cholesterol, triglycerides and BMI, and thus helped to improve the lifestyle of patients as compared to placebo group. It has shown effective results in reducing the progression of diabetes, hypertension, hypercholesterolemia and weight gain.

Limitations and Suggestions:

1. Due to Corona pandemic, it was difficult to collect study sample from any human being and extremely difficult from one place to another.
2. Large sample should be taken for more accurate results.
3. Large scale clinical trials are suggested.
4. It may also be mentioned that due to corona virus it was really difficult to get participants as everyone was paranoid of Covid-19.

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