Review Article

AMAZING FACTS ABOUT APPLE CIDER VINEGAR (ACV) –A TRADITIONAL HOME REMEDY: A REVIEW

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ABSTRACT

M. domestica fruits have many health beneficial effects for human health, mostly due to the presence of phytoconstituents which provide high dietary supplements. This article briefly reviews the general information about *Mallus domestica* fruit, description of apple cider vinegar, its chemical constituents, medicinal uses, pharmacological action. The therapeutic effects of ACV can be attributed to the bioactive constituents of the organic acids generated in ACV production, including acetic, citric, formic, lactic, malic, which have demonstrated antimicrobial, antioxidative, antidiabetic, antitumor, antiobesity, antihypertensive, and cholesterol-lowering properties in *in vitro,* animal, and human studies.

Keywords: Apple cider vinegar, Acetic acid, chlorogenic acid, poly phenols, anti diabetic, anti hyperlipidemic.

INTRODUCTION

Traditional medicine is still the foundation of about 75-80% of world population, mainly in the developing countries. Many countries such as Malaysia, Indonesia, India and China have a rich tradition of folk medicine from centuries and provided effective remedies to various ailments using plants and plants derived compounds. There is no such risk factor to use the plant medicine as compare with the allopathic drugs. The uses of complementary and traditional medicines have been increasing worldwide because of fewer side effects.

Malus domestica is a medium sized tree belonging to the family Rosaceae. The fruit is commonly known as Apple in English. Apples are consumed worldwide in the form of fresh juices and cider[1] and used for curing cancer, cardiovascular disease, asthma, and diabetes[2]. *M. domestica* fruits have many health beneficial effects for human health, mostly due to the presence phytoconstituents which provide high dietary supplements such as dietary fibre, sugars, vitamins, and phenolic compounds[3]. *M. domestica* exhibit efficient antioxidant property owing to the presence of its phytoconstituents[4]. Polyphenols are common secondary metabolites of plants, with a well known putative role in protection against the infection by plant pathogens. Apples also ranked the second for total content of phenolic compounds, including quercetin, catechin, phloridzin and chlorogenic acid, all of which are strong antioxidants, and thus capable of counterbalancing free radical activities that may cause cell injuries[5]. Apple cider vinegar is a home remedy which is widely taken by the people in Malaysia to reduce the body weight. The influence of apple cider vinegar has been investigated for hundreds of years. It was in fact first used about 5000 years ago. In the year 400 B.C., Hippocrates, the father of modern medicine, prescribed the mixture of honey and apple cider vinegar for treatment of various diseases[6]. It has been particularly used during the American Civil War for disinfecting the wounds of soldiers. More valuable properties of apple cider vinegar and its ingredients, suggesting their therapeutic effects, have been recently discovered[7]. Apple cider vinegar contains polyphenolic compounds that have beneficial health effects[8]. Its antioxidant flavonoid content can reduce the harmful effects of high cholesterol diets. Acetic acid is the main ingredient of apple cider vinegar. It is consumable at concentrations of 3-5%. It is used not only as a seasoning but also as a common a traditional medicine[9].

DESCRIPTION OF APPLE CIDER VINEGAR

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Chemical constituentst[10]:
Scientists have measured ninety different substances in apple cider vinegar such as thirteen types of carbolic acids, four aldehydes, twenty ketones, eighteen types of alcohols, eight ethyl acetates etc.
It also contains important minerals, trace elements and vitamins as well acetic acid, propionic acid, lactic acid and malic acid, enzymes, amino acids as well as roughage in the form of potash and apple pectin.

Minerals and trace elements: Potassium, Calcium, Magnesium, Phosphorous, Chlorine, Sodium, Sulfur, Copper, Iron, Silicon, Fluorine.
Vitamins: Vitamin C, Vitamin E, Vitamin A, Vitamin B1, Vitamin B2, Vitamin B6

Organic Components of ACV
Acetic acid is the most abundant compound. Organic acids from an analysis of a commercially produced ACV using high resolution H NMR spectroscopy are found in Table 1. ACV is well established that various types of phenolic compounds are found in cider apples, particularly the hydroycinnamic acid derivatives, oligomeric flavan-3-ols, dihydrochalcones, and flavonols[11] . The phenolic content of ACV will vary with cultivar and processing[12]. Phenolic content of ACV was determined to consist of gallic acid, catechin, epicatechin, chlorogenic acid, caffeic acid and *p*-coumaric acid. Chlorogenic acid is the dominant phenolic substance in ACV[13]. The total phenol content and chlorogenic acid content appear to vary significantly between different studies, possibly attributed to the different ACVs being used.

Table 1: Oganic acids in ACV

Compound	Concentration (g/L)
Acetic Acid	50.9
Citric Acid	0.02
Formic Acid	0.28
Lactic Acid	0.38
Malic Acid	3.56
Succinic Acid	0.27
Fructose	6.83
Acetoin	0.21
2,3-Butanediol	0.37
Ethanol	1.03
Ethyl acetate	0.14

MEDICINAL USES OF APPLE CIDER VINEGAR[14,15]
Cider vinegar is thought to be beneficial in the treatment of arthritis, asthma, nose bleeds, osteoporosis,highcholesterol,cold,constipation, gallstone,kidneystones,candida,colds,hayfever, headaches,hiccups,indigestion,insomnia,muscle cramps,cancer,colitis,diabetes,diarrohea, dizziness, eczema, kidney and bladder problems, metabolism, nasal congestion, sore throats, stiff joints, ulcers and weight loss. Organic apple cider vinegar helps to maintain wrinkle free skin and also it corrects p^H balance in the body. Apple juice and cider vinegar can improve memory.

- The presence of pectin in apple cider vinegar heps to reduce bad cholesterol in the body and in regulating blood pressure.
- Due to malic acid content in apple cider vinegar, it helps in fighting fungal and bacterial infection.
- Beta-carotene, an oxidant present in organic apple cider vinegar helps to maintain a wrinkle free skin.
- Potassium normalizes acid levels ($p^{H)}$ in the stomach, controls water balance in body and maintains a healthy heart rhythm.
- Magnesium is a catalyst in enzyme activity, helping digestion and assisting the uptake of calcium from healthy bones.
- Apple cider vinegar contains beta-carotene, which possesses antioxidant properties that counteract damage caused by free radicals.
- The anti inflammatory properties of apple cider vinegar work to soothe the effects of sunburned skin when added to a bath.
- Apple cider vinegar also useful in weight loss.

PHARMACOLOGICAL ACTIVITIES

- **Anti-hyperlipidemic[16]:** Abnormal metabolism of lipids leads to the elevated levels of fatty substances largely cholesterol and triglycerides into blood stream leads hyperlipidemia. Apple cider vinegar was prepared and evaluated for anti hyperlipidemic activities in rat model. Hyperlipidemia was induced by feeding high cholesterol diet. ACV (1ml/day) and standard drug atorvastatin were administered to the animals in respective groups and fed with high cholesterol diet for 14 days except normal control rats. A significant increase in reduced HDC-L level and significant decrease in elevated level of TC, TG, LDL and VLDL level were observed in ACV treated rats when compared to cholesterol fed rats. The result concluded that ACV has significant anti-hyperlipidemic activity in HCD induced hyperlipidemia.

- **Anti oxidative**[17] **-**. ACV has a number of phenolic compounds that contribute to its antioxidative capacity, including gallic acid, catechin, epicatechin, chlorogenic acid, caffeic acid, and p-coumaric acid[13].A study was conducted on fifty-four adult male wistar albino rats which were fed with high cholesterol diet for 7 weeks. Rats were sacrificed at the end of the experiment and blood samples were collected. Catalase (CAT) activity, malondialdehyde level (MDA), glutathione peroxidase (GSH-Px) activity, superoxide dismutase (SOD) activity were studied. Levels of CAT, GSH-Px, SOD were significantly decreased in high-cholesterol diet group (CHCNT) .Levels of MDA, which is the end product of lipid-peroxidation was significantly decreased in the apple cider vinegar administration group when compared to the CHCNT (P<O.O5). Thus study indicated that apple cider vinegar produced by surface method seems to have favorable anti-oxidant effect *in vivo* .
- **Ant diabetic -** The most established therapeutic effect of ACV is seen in its anti diabetic activity. In both animals and humans, acetic acid (80% of ACV), has significantly improved insulin sensitivity and suppressed the drastic rise in blood glucose after meals. A pilot study found that two tablespoons of ACV at bedtime reduced morning blood glucose by 4-6%, results that further indicate the anti glycemic capacity of ACV[18]. Anti diabetic effect of apple cider vinegar was performed using streptozocin induced diabetes in mice. The mice were divided in six groups. Two concentrations of 0.16% and 6% concentration of apple cider vinegar were used in drinking water for 21 days. In this study it has been revealed that apple cider vinegar has considerable reducing effect on blood glucose level in diabetic mice[19].
- **Anti tumor -** Although little research has been performed on ACV or acetic acid and their involvement in the inhibition of tumor growth, the involvement of ACV's anti oxidative activity inherently plays a role in early stages of tumor development. One study did investigate the products of acetic acid fermentation present in the production of ACV and found a dose-response effect on the content of medium-sized alpha-glycans, active against tumors in experimental mice[20].
- **Anti obesity -** The anti obesity effect of ACV can, from what we know, be attributed to its earlier induction of satiety. Variable results have been demonstrated in studies evaluating the rate of gastric emptying when preceding a meal with ACV; however some have showed a slower rate, which would induce satiety sooner, confirming the biologic plausibility of ACV's involvement in weight loss[21].
- **Antifungal activity**[22] **–***In vitro* assessment of anti fungal potential of apple cider vinegar and acetic acid was carried out on 18 patients with aural symptoms suggestive of otomycosis.18 samples were examined 13(72%) of them were positive for fungal growth, 6(46%) of fungal isolates were Aspergillus niger,1(8%) was Aspergillus flavus,2(15%) were Candida albicans and the 4(30%) were non Candida albicans. Apple cider vinegar (5%) inhibits the growth of Aspergillus niger, Aspergillus flavus, Candida albicans and non Candida albicans with average diameter of inhibition zones 15mm, 13mm,17.5mm,17mm respectively.
- **Nootropic activity**[23]**:** Cognitive enhancing activity of apple cider vinegar on scopalamine induced memory impairment in mice was investigated by using elevated plus maze and estimation of biochemical parameter in terms of acetylcholine esterase activity. Two doses (0.51 ml /kg) and (1.02 ml/kg) of ACV were subjected for the evaluation of nootropic activity against the amnesia induced by scopalamine in young mice. The long term administration of both lower and higher dose ACV produced significant reduction of TL(P<0.01) and(P<0.05) in EPM model on both 19th and 27th day when compared with control and induced group.ACV at higher doses significantly reduces the activity of AchE indicated improvement in learning and retention of memory in young mice.
- **Cholesterol-lowering Effect**[24] - The polyphenol content of vinegars, most notably the high content of chlorogenic acid in ACV, has suggested a potential

inhibition of LDL oxidation in the blood stream, however further research is warranted in this area. In animals, acetic acid and concomitant cholesterol, reduced serum triglyceride levels by inhibiting lipogenesis and promoting exertion of triglycerides in fecal bile acid excretion, further suggesting its protective effect on risk factors of heart disease mainly atherosclerosis.

NOTABLE RESEARCH WORK ON APPLE CIDER VINEGAR

- **Ajaykumar TV. *et al*** evaluated the anti hyperlipidemic activity of apple cider vinegar in experimental rat models.
- **LaszloBardos, Balazs Bender** investigated the effect of apple cider vinegar on blood and liver cholesterol, triglycerides and one of a marker of anti oxidant status of blood in laboratory mice.
- **Hayder Badr Jabir M *et al*** reported the antifungal potential of apple cider vinegar and acetic acid to find a safer alternative to traditional antifungal drugs in treatment of otomycosis.
- **Zahra Behshtil *et al*** investigated the early prevention and treatment of atherosclerosis can prevent complications of cardio vascular diseases by the influence of apple cider vinegar consumption on reducing blood lipid levels.
- **Zahra Vahdat Shariatpanahi *et al*** evaluated the effect of apple cider vinegar plusPPI- based triple therapy on eradication of helicobacter pylori(H.pylori) infection.116 patients with H.pylori infection were included in this randomized clinical trial.
- **Amin T.Hamed *et al*** designed to determine and compare the effect of apple and grape vinegars on lipid profile in male Albino white rats.
- **Shishehbor F *et al*** investigated the effect of apple cider vinegar on fasting blood glucose, glycated haemoglobin(HbAlc) and lipid profile in a normal and diabetic rats.
- **Soujanya *et al*** evaluated nootropic potential of apple cider vinegar in validated experimental animal model.
- **Nazar AA Omar *et al*** investigated hepatoprotective and anti diabetic properties of apple cider vinegar on liver of male rats.
- **Joanna Morgan – Sapha Mosawy** investigated the potential apple cider vinegar in management of type II diabetes.
- **Ahmed saber - Abu Zaiton** investigated the effect of apple cider vinegar on physiological state of pancreas in normal and alloxan induced diabetic rats.
- **Derya A, Cem A and Celalettin K** investigated the effect of external apple vinegar application on varicosity symptoms, pain and social appearance anxiety: a randomized control trial.

CONCLUSION

In the present review an attempt has been made to reveal the active constituents, medicinal uses and pharmacological activities of Apple cider vinegar. It reveals that apple cider vinegar contains several phytoconstituents like acetic, chlorogenic acid, gallic acid and several phenolic components. The ACV is a readily available product that is easily able to be incorporated into meals. Large body of research has demonstrated its beneficial properties as an entire product, as well as the abilities of the individual components. Literature surveys revealed that Apple cider vinegar has a great perspective in the treatment of several diseases and it possesses anti hyperlipedemic, anti diabetic, nootropic, anti-oxidative, anti-fungal, anti obesity and anti-tumor effects . Further evaluation need to be carried out in order to explore the concealed areas and their practical clinical applications, which can be used for the welfare of mankind.

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