

Health Benefits of Vinegar on Human Health: A Review

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Abstract: An organic substance produced through fermentation is vinegar. Good sources of substrate for the production of vinegar are foods high in carbohydrates. The flavor and aroma of vinegar make it a popular element in culinary preparations. The most well-known folk remedy for treating infections is this one. Vinegar has long been utilized in medicine to treat ailments like edema, burns, rashes, and stomach problems. There is a large variety of vinegar available in the world, including fruit, rice, black, balsamic, and grain varieties. They have distinct flavors and tastes since they are made with various basic ingredients and fermentation techniques. In addition to improving metabolic processes like lipid metabolism, blood glucose regulation, and body weight control, vinegar has antibacterial, antioxidant, anticancer, and anti-infection qualities. Many bioactive substances, such as organic acids, ligustrazine, polyphenols, melanoidin's, and tryptophol, are thought to be abundant in it. These bioactive substances in vinegar are thought to be the cause of its pharmacological and metabolic advantages. Vinegar may help treat obesity, diabetes, heart disease, cancer, and microbiological infections, according to several studies. The healing properties of vinegar may be attributed to the presence of acetic acid and other ingredients. In this publication, recent research on the medicinal benefits of vinegar obtained from various food sources is reviewed. There is also a discussion of vinegar's potential medicinal effect mechanisms.

Keywords: Vinegar, Fermentation, Carbohydrates, Obesity, Diabetes, Microbial infections.

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Introduction

Naturally occurring in foods such as apples, dates, grapes, figs, and many other carbohydrate-rich items, vinegar is produced by fermentation processes (first alcoholic, then acetous) that contain fermentable glucose (1). Because of vinegar's therapeutic benefits, it has historically been produced for medical purposes. One of vinegar's well-known health-promoting qualities is its antibacterial activity, which also helps to prevent harmful health effects (2). Vinegar has been utilized historically since the 18th century as a medicinal remedy for laryngitis, obesity, fever, swelling, and stomach problems (3). One of vinegar's well-known health-promoting qualities is its antibacterial activity, which also helps to prevent harmful health effects (2). Vinegar has been utilized historically since the 18th century as a medicinal remedy for laryngitis, obesity, fever, swelling, and stomach problems (3). In the food industry, vinegar is frequently used to pickle fruits and vegetables and to make condiments. According to Chen (3) vinegar contains a variety of bioactive substances that have a range of health benefits, such as antibacterial, anti-infection, antioxidant, blood glucose regulation, and weight management. These compounds include organic acids, melanoidin, polyphenols, tryptophol, ligustrazine, and caffeoylsophorose (4). Depending on

the bioactive ingredients included, different varieties of vinegar may offer varying health benefits. Vinegar has very little toxicity when used as a culinary ingredient or medicinal substance. Nonetheless, consuming large amounts of vinegar with an acetic acid content of more than 20% may have negative effects on human gastrointestinal health and mouth health (5). Thus, the goal of this analysis is to illustrate the various varieties of vinegar that are available globally, taking into account the primary components utilized in their manufacturing, the health advantages linked to the presence of particular bioactive compounds, and the toxicological consequences. A summary of the regulations about vinegar drinking is also provided.

Types of Vinegar:

There are a plethora of vinegar varieties available, maybe far more than what you have stored in your kitchen cupboards. A different component, such as wine, rice, barley, or apple cider, is fermented to produce each kind. But depending on the type of rice or wine used, for example, there are many more variations within each of those types. Each variety has distinct qualities, acetic acid contents, and flavor characteristics even though they are all sour and acidic. To create distinctive flavor profiles, several specialty kinds of vinegar are infused with various herbs, spices, and fruits.

1. Apple cider vinegar:

Among fruit vinegars, apple cider vinegar is one of the most well-known worldwide. Cider vinegar is made by fermenting apple juice in both an alcoholic and acetous state, which first turns the sugars into alcohol and then acetic acid (6). Vitamins, minerals, and dietary fibers are just a few of the components found in apple cider vinegar. According to Kausar (7), there is a popular vinegar that is used to treat a variety of ailments, such as obesity, diarrhea, asthma, skin and hair issues, and many more. Apple cider vinegar has long been used as a preservative and flavor. Apart from that, it's being utilized in marinades, chutneys, and salad dressings. Known by its common name, "cider vinegar," it is primarily found in North America and the United States of America (8).

2. Sugarcane vinegar:

Made from sugar crops, or sugarcane, sugarcane vinegar is both sweet and sour. It is made by extracting juice from ripe sugarcane stems, sterilizing them, and then putting them through an alcoholic fermentation process (9-12), acetic acid, as well as further microbial fermentation methods. This vinegar product is of an advanced type (13-16). Sugarcane Original Vinegar (SOV) maintains functional nutrients and nutritionally rich properties, according to earlier research. In addition to flavonoids and phenols, the main constituent is acetic acid. Other organic acids included are tartaric, oxalic, and succinic acids (17). Compounds with specific functions, such as phenolic acids (18), rich in various types of amino acids (19), and benzoic, ferulic, quinic, chlorogenic, apigenin, kaempferol, caffeic, luteolin, and p-coumaric acids. There are few investigations on the safety and functional assessment of sugarcane vinegar because it is a more sophisticated variety of vinegar.

3. Balsamic vinegar:

Italy's Modena and Reggio Emilia are the producers of balsamic vinegar, which is among the most well-known vinegar in Europe. Since its miraculous therapeutic properties were believed to be useful, for example, in the fight against the plague, the word "balsamic" derives from the word balm (medicinal ointment). This vinegar was first mentioned in the eleventh century when it was presented to Henry III, the Emperor of the Holy Roman Empire. It was given to other notable figures as a gift in the centuries that followed (20). According to Solieri (21), the cooked grape raw material must have a pH of 2.3–3.2 and a soluble solids concentration (above all glucose and fructose) ranging from 20 to 60°Bx. It's made via a two-step fermentation procedure, just like other vinegars. AAB oxidizes the ethanol in the first one to acetic acid, while fermentable sugars are transformed by yeasts to ethanol in the second, yielding an ethanol level of 4–10%. The fermentation process takes place naturally in both phases. While retaining the tart edge of vinegar, balsamic offers a deep flavor. Well, known as a beneficial addition, it's a common ingredient in glazes, sauces, and reductions and is a mainstay of Italian cuisine. Balsamic vinegar is a terrific method to add flavor to healthy recipes without adding fat or sodium because it is low in calories.

4. Malt vinegar:

Since malt is high in nutrients and enzymes, it is used as an auxiliary or additional raw material in many areas of food technology (malt flour, for example, is used as an additive to enhance the nutritional content and sensory qualities of wheat flour and other flour varieties). Additionally, it serves as a raw material for the manufacturing of malt extracts and syrups, which are used to make baby food, alcoholic and soft drinks, sauces, vinegar, and a variety of other goods in addition to sweets, biscuits, and related products (22). Germ, another byproduct of malting, is a food supplement that is high in nutrients (23). There are no recognized malting wheat (*Brauweizen*) varieties in Croatia. Nonetheless, given ideal climatic and agro-technical circumstances, a few winter wheat cultivars can produce high-quality malt. If the right malting procedures are followed, less acceptable wheat (defined as having lower bread-making quality parameters combined with a high grain yield potential) for use in the baking business can be used as a raw material for malting.

5. Rice vinegar:

Rice vinegar is a type of vinegar produced in Southeast Asia's Vietnam and East Asia's China, Japan, and Korea from fermented rice. Sushi, jiaozi, and banchan are just a few of the meals that employ it as a spice, dressing, or dipping sauce. Compared to other Chinese vinegar, white rice vinegar is more acidic, yet it still has a softer flavor and is colorless to pale yellow in liquid form as per Parkinson (24). After soaking the rice in water, it is heated and cooled, and then koji mold is used to saccharify the starch in the rice. According to Budak (25), acetic acid is created by bacteria known as *moromi* through static surface fermentation, whereas sake yeast is used to produce sake from rice. Based on where they came from, several kinds of rice vinegar can be discovered.

6. Fruit vinegar:

Fruit vinegar (FV) is a popular natural product with multiple use purposes. It is remarkably appreciated and included in many people's daily diet (26-28). Fermentation produces a bio liquid that contains several functional molecules (29,30) such as organic acids (30,31), polyphenols (32,33), melanoidins (34,35) and tetramethyl pyrazine (36,37). It is connected to the raw matter by its mineral content in FV. Regarding human nutrition, it is significant. The creation of blood cells, blood pressure regulation, muscular contraction, bone and tooth health maintenance, sleep modulation, and nerve function maintenance are just a few of the physiological processes in which minerals are engaged. A healthful product, fruit vinegar has many applications. Thanks to its capacity to lower inflammatory cytokine levels, it is utilized to combat inflammation (38,39).

Health Benefits:

As a natural food, vinegar has several possible medical uses. Vinegar's health benefits may be due to the presence of bioactive chemicals and acetic acid. It has been demonstrated that vinegar, from a variety of sources (fruit vinegar, vegetable vinegar, apple cider vinegar, and others), may help with cancer, diabetes, obesity, heart disease, and other health issues.

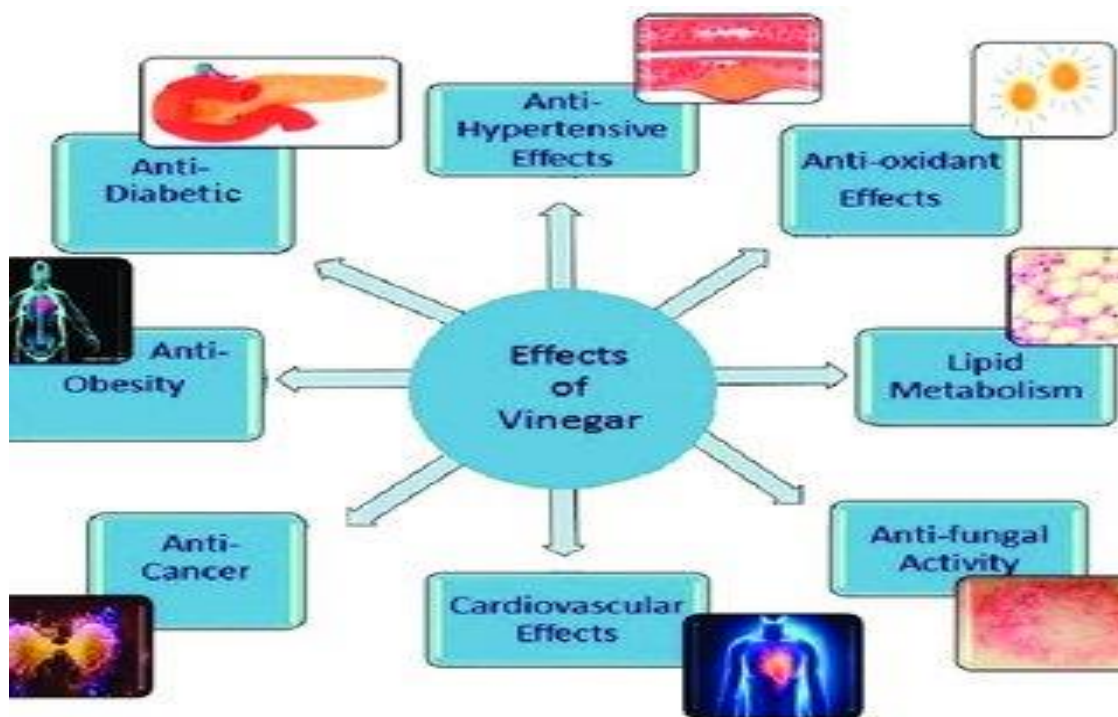


Fig 1: Effects of vinegar

1. **Anti-infective Properties:**

The antibacterial effects of vinegar have been demonstrated by recent scientific investigations, mostly concerning food preparation (40-43). Professionals advise avoiding treating wounds with vinegar mixtures (44). Although vinegar is frequently suggested in the media to treat warts, head lice, and nail fungus, there is insufficient scientific evidence to back up these treatment methods. The primary cause of vinegar's antibacterial and anti-infective properties is its organic acid content, specifically polyphenols and melanoidins (45), and the low pH levels brought on by acetic acid's role as the main ingredient (46). Bacteriostatic and bactericidal activities are the two categories of bacterial actions that vinegar can have. In contrast to bactericidal activity, which includes a decrease in the number of viable cells, bacteriostasis involves the inhibition of bacterial growth. *Salmonella* spp. and *Escherichia coli* food poisoning was mostly prevented by the bactericidal action.

2. **Cardiovascular Effects:**

Chronic heart conditions (CHDs) are recognized as a leading cause of death in the general population. High blood pressure, cholesterol, physical inactivity, and smoking are a few of the major risk factors for CVDs (47). Several earlier studies have clinically demonstrated the potential of foods high in polyphenols, such as vinegar, to lower mortality and improve protection against CVDs (48). Chronic inflammation of the arterial blood arteries caused by atherosclerosis can cause clinical events such as myocardial infarctions, angina, and eventually mortality. A brief rise in blood levels of TG and fatty acids after meals can impact endothelium-dependent vasodilatation, the primary mechanism driving the development of atherosclerosis (49). According to Setorki (50), phenolic chemicals found in fruits, vegetables, and fruit juices are deemed beneficial to human health. Additionally,

vinegar has a postprandial influence on reducing the biochemical risk factors associated with atherosclerosis.

3. **Blood Glucose Effect:**

Consuming vinegar may have an impact on blood sugar levels. Intake of vinegar has been shown to significantly enhance glycaemic control in people with type 2 diabetes (51). According to the American Diabetic Association (2010), diabetes mellitus is a chronic metabolic disease brought on by either the body's incapacity to create enough insulin or the pancreas' incapacity to keep the body's insulin levels enough for metabolic processes. Elevated blood glucose levels during fasting and after meals are the hallmarks of diabetes, according to the World Health Organisation. According to Yang (52), postprandial hyperglycemia is thought to be the typical symptom for identifying diabetes mellitus in its initial stages. Vinegar's acetate contributes to the breakdown of blood glucose into glycogen, which lowers fasting blood sugar levels (53). Furthermore, it has been demonstrated that consuming one tablespoon of vinegar twice a day at dinner will lower a person's fasting blood glucose level to an equivalent degree to the frequent administration of diabetic medications (54).

4. **Antioxidant Effects:**

Superoxide, hydrogen peroxide, and hydroxyl radicals are examples of reactive oxygen species that have been shown to impact DNA, lipids, and proteins, leading to cancer, brain degenerative diseases, and accelerated aging (55,56). Because of their strong antioxidant activity, bioactive components including vitamins and polyphenols found in many types of vinegar protect against oxidative stress (57,58). As per Ubeda (59), the wild yeast strain utilized in the manufacturing of persimmon vinegar was responsible for its increased

antioxidant activity value, which was shown to be greater than that of white and red wine vinegar.

5. **Anticancer Effects:**

The polyphenol content of vinegar, particularly that of polyphenols like resveratrol, is linked to its anticancer properties (60). Rich in polyphenols and acetate, vinegar boosts antioxidant defences while reducing carcinogenic effects. A study by Xibib (61) examined the impact of grain vinegar on oesophageal cancer, and the findings showed a negative correlation. Acetate in vinegar has also been demonstrated by Baba (62) to restrict the growth of colon cancer cells in cell-based tests. Leukaemia is a blood malignancy characterized by an abnormal rise in white blood cell numbers in the body. Research by Mimura (63) has demonstrated that vinegar increases the death of human leukaemia cells, which lowers the incidence of leukaemia. As stated by the Vinegar Institute in 2005, the inhibition of glycolysis lowers the production of new cancer cells while starving the cancer cells that are already there and responsible for the body's cancerous growth. The three known mechanisms that influence vinegar's anticancer properties in humans are the oxidative stress of polyphenol concentrations, acetate's ability to inhibit the growth of cancer cells, and cancer cells' apoptosis.

Other health effects of vinegar:

While many other health benefits of vinegar have been linked to its bioactive constituents, these benefits have not been thoroughly detailed in scientific studies. Thanks to its ability to heal burns, vinegar has been utilized as medicine since ancient times. The primary hypothesis behind vinegar's therapeutic benefits is its antimicrobial characteristics (64). According to the same research, acetic acid bacteria are responsible for the synthesis of sphingolipid precursors, which are thought to be the fundamental units of brain tissues. It has been determined that vinegar is a medicinal agent with few adverse effects. Additionally, historical documents of the use of vinegar mixed with honey as a chronic cough syrup are recorded (65).

Conclusion:

Since ancient times, vinegar has been used as a spice, medicine, and food preservation component. Around the world, different varieties of vinegar are being created using different basic components. Because of its several pharmacological qualities, vinegar can operate as an antibacterial, antifungal, and anti-inflammatory agent, all of which are good for human health. Additionally, it can support healthy blood sugar regulation, heart health, fat metabolism, weight control, digestive issues, and kidney health. These health advantages are ascribed to the bioactive substances found in vinegar, including organic acids, ligustrazine, melanoidins, and polyphenols. Because it is not very poisonous, vinegar is by default regarded as a safe food to eat.

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Conflict of Interests:

The authors state they have no relevant conflicts of interest

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