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An overview on types, medicinal uses and production of vinegar

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Abstract
Vinegar is the fermented product which consisting about 5-20% of acetic acid, prepared by fermentation of alcohol with the help of *Acecobactor* species. Vinegar is the food additive it is used in ketchup, salad dressing and in pickle. It is also used as food preservatives. The use of vinegar as a medicine is firstly carried out by Hippocrates. He used vinegar for the treatment of wound healing. Different types of Vinegar are present in the world. The different possible medicinal uses of Vinegar are reviewed in the present review. Vinegar is used as Antidiabetic, Antimicrobial, Antioxidant, Antitumor, Antiobesity, it reduces Cholesterol level, it maintains different Brain functions and it is also used in Injuries. In present Article we are reviewed all previous work which are carried out on the Vinegar including Method of preparation, Characterization of Vinegar and uses of Vinegar etc. The Vinegar is prepared with the help of different methods like artificial method and natural fermentation method etc. The characterization of Vinegar is mainly carried out with the help of following tests pH, Titratable acidity, Specific gravity etc.

Keywords: Vinegar, types, uses of vinegar, fermentation, characterization

1. Introduction
Vinegar is prepared by different methods and from various raw materials. Wine (white, red, and fortified wine), cider, fruit musts, barley, or pure alcohol is used as substrates. Vinegar production ranges from ancient strategies using wood casks and surface culture to submerged fermentation in acetators. Vinegar historically has been used as a food preservative. Whether naturally produced during fermentation or intentionally added, vinegar retards microbial growth and contributes sensory properties to a number of foods. The wide diversity of merchandise containing vinegar (sauces, ketchup, mayonnaise, etc.) and therefore the current fall in wine consumption have flavoured a rise in vinegar production. Acetic acid is that the predominant flavourer and antimicrobial part in vinegar. The following review can specialise in the importance of carboxylic acid as an on the spot additive or a lot of recently as a food process aid, to clean food before distribution and consumption. Earlier methods used for creating vinegar were the Orleans process (which is additionally referred to as the slow process), the fast method (which is additionally known as the generator process), and the submerged culture process. The quick method and submerged culture method were developed and used for industrial vinegar production nowadays. Acetic acid is made in an exceedingly four-step reaction involving conversion of starch to sugar by amylases, anaerobic conversion of sugars to alcohol by yeast fermentation, conversion of ethanol to hydrated ethanol, and dehydrogenation to acetic acid by aldehyde dehydrogenase. The last 2 steps performed aerobically with the help of acetic acid forming microorganism. Acetic acid yield from soured sugar is about four-hundredth, with the remaining sugar metabolites either lost to volatilization or converted into other compounds. Acid yield enhancements may be achieved victimization high rates aeration of throughout continuous production. Vinegar bacteria, also called acetic acid bacteria, are members of the genus Acetobacter and characterized by their ability to convert ethyl alcohol, C2H5OH, into acetic acid, CH3CO2H, by oxidation as shown below;
Anaerobic Aerobic

$2C_2H_5OH \rightarrow 2CH_3CHO \rightarrow 2CH_3CO_2H + 2H_2O$

Most microorganism strains derived from vinegar factories are able to oxidize acetic acid to carbonic acid gas and H2O (over-oxidation) and thus square measure classified within the genus Acetobacter Common kinds of vinegar embody white distilled vinegar, cider vinegar, wine vinegar, rice vinegar, and malt vinegar. Further process of vinegar, following substrate conversion to acetic acid may include filtration, clarification distillation and pasteurization at

165.2°F (74°C) before it is bottled. Labels characteristic the diluents wont to meet the listed concentration of acid also are needed. Acetic acid concentration in vinegar is also expressed victimization the term "grain". For example, 100 grain distilled vinegar is a 10% acetic acid solution. If higher concentration of carboxylic acid is needed, the dilute solution of acetic acid maybe heat distilled or frozen to slush. The slush is centrifuged to isolate the liquid portion. Concentration from 10-30% is also achieved victimization this method. Vinegar plays a crucial role in dish dressings, ketchup, hot sauce and other sauces. This need demands industrial fermentation systems capable of producing a large amount of vinegar. These systems should maintain reliable controls and optimum conditions for carboxylic acid microorganism fermentation. Many techniques are developed to enhance industrial production of vinegar. Most try to increase the speed of the transformation of ethanol into acetic acid in the presence of the acetic acid bacteria. Today, the foremost common technology for the vinegar trade is predicated on the submerged culture with various technical modifications that attempt to improve the final fermentation conditions (Aeration, stirring, heating, etc.) [1, 2, 7].

2. History

Vinegar is the world's oldest cookery ingredient and food preservation methodology. According to the Vinegar Institute (Vinegar Institute 2005), vinegar's use may be derived back over ten thousand years. In fact, seasoned vinegars are factory made and oversubscribed from five, thousand years. The wide variety of vinegars available today is nothing new. Until the six century BC, the Babylonians were making and selling vinegars flavoured with fruit, honey, malt, etc. to gourmets of the time. In addition, the Old Testament and Hippocrates recorded the employment of vinegar for dedicative functions. There are other historical reports about vinegar. Albucases in 1100 made the statement that colorless vinegar must be distilled over a low fire. Basilius Venlentinus, a monk, in the fifteenth century found that by distilling weak vinegar, a stronger product could be obtained. The Geber within the seventeenth century discovered increasing the strength of vinegar by distillation. Chemist Stahl in the first half of eighteenth century discovered the sour principle of vinegar was acetic acid. In 1790, Loewitz, reported that running weak acetic acid over charcoal would strengthen it. Durande in 1778 made a more concentrated product and called it glacial acetic acid. The first complete analysis of acetic acid was made by Berzelios in 1814. Dobereiner established that alcohol was alter at the expense of chemical element and made acetic acid and water. In 1823 Schutzenbach introduced the quick process of manufacturing vinegar based on Dobereiner's theory of formation of acetic acid from alcohol. In 1955 Joslyn reported that Hromatka developed a new method of making vinegar called submerged acetification [1, 9].

3. Advantages of vinegar

- It helps to lower bad Cholesterol.
- It may reduce risk of cancer.
- It keeps our body hydrated.
- It helps to boost our immune system.
- It helps to decrease risk of cancer.
- It acts as antioxidant.
- It reduces elevated body weight.

4. Types of Vinegar [3]

4.1 Balsamic vinegar

Balsamic vinegar is brown in color with a sweet-sour flavour. It is prepared from the white Trebbiano grape and aged in barrels of different woods. Some gourmet Balsamic vinegars are over 100 years old.

4.2 Cane vinegar

Cane vinegar is prepared from agitated sugarcane and has mild, rich-sweet flavour. It is most commonly used in Philippine cooking.

4.3 Champagne vinegar

Champagne vinegar has no bubbles. It's prepared from a still, dry white wine made from Chardonnay or Pinot Noir grapes (both of which are used to make Champagne).

4.4 Cider vinegar

Cider vinegar is made from apples and is the most popular vinegar used for Cooking in the United States.

4.5 Coconut vinegar

Coconut vinegar is low in acidity, with a musty flavour and a unique aftertaste. It is used in many Thai dishes.

4.6 Distilled vinegar

Distilled vinegar is harsh vinegar made from grains and is usually colorless. It is best used only for pickling.

4.7 Malt vinegar

Malt vinegar is very popular in England. It's made from fermented barley and grain mash, and flavoured with woods such as beech or birch. It has a hearty flavour and is often served with fish and chips.

4.8 Rice wine vinegar

Rice wine vinegar has been made by the Chinese for over 5,000 years. Three forms of rice wine vinegar are there: red (used as a dip for foods and as a seasoning in soups), white (used mostly in sweet and sour dishes), and black (common in stir-fries and dressings).

4.9 Sherry vinegar

Sherry vinegar is aged bellow the complete heat of the sun in wood barrels and shows a nutty-sweet flavour.

4.10 Wine vinegar

Wine vinegar prepared from white, red, or rose wine. These vinegars make the best salad dressings.

5. Uses of vinegar

Vinegar is used as food additive. It is also used in the different physical abnormalities as a medicine. The different medicinal uses of vinegar are as an Antimicrobial, as an Antioxidant, as an Antitumor, as a Antiobesity agent, it reduces the cholesterol level, it also maintains body weight. It also reduces the Diabetes.

5.1 Antimicrobial [5, 9]

Vinegar has antimicrobial properties which makes it useful for a number of applications. Vinegar has been used for cleaning and treating nail fungus, head lice, warts, and ear infections. Consumers typically prefer natural preservative methods for inhibiting the growth of foodborne pathogenic

microorganisms in food. The organic acids in vinegar and mainly acetic acid pass into cell membranes of microorganisms leading to bacterial cell death. The bacterial strains, temperature, pH, acid concentration and ionic strength influence the antimicrobial activity of organic acids. Many organic acids are naturally found in a variety of fruits and fermented foods, including: acetic, lactic, ascorbic, citric, malic, propionic, succinic, and tartaric acids and in non-excessive levels, none of these acids are dangerous to human health. Different studies have reported that vinegar could be used to inhibit pathogenic bacteria on fresh fruits and vegetables.

5.2 Antioxidant [6, 9]

Reactive oxygen species such as superoxide, hydrogen peroxide, and hydroxyl radical have been reported to affect lipids, proteins and DNA resulting in accelerated aging, cancer, and brain degenerative disorders. Bioactive compounds in foods might decrease incidences of these chronic diseases by providing an antioxidant result. Bioactive substances such as polyphenols and vitamins in different types of vinegar defend against oxidative stress due to their significant antioxidant activity. Oxygen Radical Absorbance Capacity (ORAC) and Trolox Equivalent Antioxidant Capacity values of traditional vinegar were higher than industrial vinegar. ORAC and TEAC values of wine vinegar were higher than apple cider vinegar. The Japanese rice vinegar Kurosu had a high composition of compounds like phenol showing it is a strong source of antioxidant activity. The antioxidant activity value of persimmon vinegar was higher than white and red wine vinegars;

5.3 Antitumor [9]

Kurosu is traditional Japanese rice vinegar which is reported to be 1 of the most important sources of phenolic compounds for reducing cancer risk. Antioxidant activity of associate degree ester extract of Kurosu vinegar was bigger than the inhibitor activities of wine and apple vinegars. The result of Kurosu vinegar on the proliferation of a range of human neoplastic cell lines has been studied. Cancer cell lines included colon adenocarcinoma, lung carcinoma, breast adenocarcinoma, bladder carcinoma, and prostate carcinoma cells. It was reported that Kurosu inhibited the proliferation of all tested cell lines in a dose-dependent manner. Kibizu is sugarcane vinegar produced in Japan. Kibizu smothered the expansion of typical human malignant neoplastic disease cells with its potent radical scavenging activity. Vinegar ingestion indicated a protective effect with a decreased risk for esophageal cancer. Products of alcohol and acetic acid fermentations that were formed during the production of apple vinegar were investigated with regard to the neutral medium sized alpha-glycancontent, which acts against experimental mouse tumors. It was observed that neutral medium-sized alpha-glycan was formed mainly during acetic acid fermentation, but not during alcohol fermentation.

5.4 Antiobesity agent [9]

Vinegar uptake could decrease the glycemic result of a meal through satiation so reducing the full quantity of food consumed. Lim and others used an obese insulin resistant rat model to evaluate the anti-hyper glycemic and Antiobesity effects of ginsam which is a vinegar extract from Panax ginseng. Ginseng is 1 of the most popular herbal medicines in particularly Asian populations. Panax ginseng is known that has several pharmacologic and physiologic effects. The rats fed ginsam had lower body weight and fasting, postprandial glucose and plasma insulin concentrations than the controls. Human subjects consuming 2 tablespoons of red raspberry vinegar daily with freely access to food and water for 4 wk lost weight whereas the control group consuming a similar amount of cranberry juice daily for 4 wk had a slight weight gain. In another study, healthy volunteers consumed 3 levels of vinegar (18, 23, and 28 mmol acetic acid) with a portion of white wheat bread; bread consumption (no vinegar) was used as a control meal. When the hunger and satiety feelings of volunteers were evaluated it was noted that satiety increased with rising acetic acid level. Johnson and Buller studied 3 treatment conditions (control, consumption of vinegar containing 1 g acetic acid, or consumption of approximately 1 oz of peanuts for satiety). In the study, participants ingesting vinegar or peanuts had lower subsequent food consumption accounting for approximately 200 to 275 calories per day. After consumption of the bagel meal, energy consumption for the remainder of the day was weakly affected by vinegar and peanut treatments. This daily calorie reduction would end in a monthly weight loss of one to 1½ pounds. Budak and others (2011) identified a significant steatosis in rats fed the high-cholesterol diet when compared to the control group. Apple potable vinegars created victimisation the submersion methodology showed significantly diminished steatosis in teams fed these merchandise compared to the high-cholesterol diet cluster.

5.5 Prevention of Cardiovascular Diseases

5.5.1 Cholesterol-lowering effect [8, 9, 10]

Cardiovascular disease is the leading cause of mortality accounting for more than half of the total mortalities. Cholesterol, elevated blood pressure, smoking, and physical inactivity are among the major risk factors for cardiovascular disease. Many medicine studies show that polyphenol-rich foods give protecting impact and scale back mortality from diseases. Atherosclerosis induces chronic diseases. Atherosclerosis is a chronic inflammatory disease initiated by the sub endothelial retention of low density lipoprotein (LDL) particles. The initiation and progression of coronary-artery disease primarily dependent upon aerophilous stress and therefore the formation of change LDLs. Consumption of natural antioxidants like polyphenols might decrease the formation of change LDLs within the blood. Polyphenols like chlorogenic acid that is gift in high levels in apple vinegar may inhibit chemical reaction of LDLs and improve health by preventing vas diseases. The lipid profile of blood depends on genetic factors and dietary habits such as the consumption of food containing high levels of saturated fat. Fushimi and others reported that 0.3% dietary acetic acid reduced serum cholesterol and triglycerides (TG) in rats fed a cholesterol rich diet. *In vivo*, acetic acid enhanced lipid homeostasis and the cholesterol-lowering effect of acetic acid was described in detail by Yamashita and others. Budak and others determined the cholesterol-lowering effect of apple vinegars in rats fed high-cholesterol diets and identified the serum levels of TG, total cholesterol (TC), high-density lipoprotein (HDL), LDL, and very low density lipoprotein (VLDL) of each of the groups. Serum levels of TG, TC, HDL, LDL, and VLDL significantly increased in rats fed the high-cholesterol diet when compared to the control. The increase of lipoprotein level was significant solely in rats fed apple vinegar created by the surface technique with

maceration. The increase in LDL level was significant in the groups fed apple cider vinegars produced by the surface method, and by the submersion method with or without maceration. It was additionally noted that LDL level didn't increase within the teams fed apple potable vinegars created by the surface technique with maceration.

5.5.2. Anti-hypertensive effect [10]

Studies have investigated the effect of vinegar on lowering blood pressure. These studies have examined oral administration of vinegar on the renin-angiotensin system *in vitro* and *in vivo* using spontaneously hypertensive rats-stroke prone. Ohnami and others observed that an ethanol extracted fraction of rice vinegar residues prevents angiotensin-converting enzyme (ACE) activity in spontaneously hypertensive rats. Nishikawa and others reported rice vinegar residues prevent ACE activity in the blood pressure regulatory system. Melanoidins, which are synthesized in the final stage of the Maillard reaction during traditional balsamic vinegar production, exhibit potential health benefits including antihypertensive activity. Although studies have shown that minor components of vinegar are responsible for the observed antihypertensive effects, the acetic acid content of vinegar is reported to also cause an antihypertensive effect. Vinegar and acetic acid ingestion reduced plasma renin activity and plasma aldosterone which are factors associated with blood vessel constriction in rats.

5.6 Therapeutic effect of vinegar for injuries [11]

Mother of vinegar has been revealed therapeutic result on burns because medicinal properties. In addition, it was reported that the extracellular structure synthesized by Acetobacter xylinum assisted tissue repair in rats. Sugiyama and others suggested that oral intake of AAB was useful in attenuating muscle damage by inflammation after moderate-intensity exercise.

5.7 Impact of vinegar on brain [12]

Sphingolipids are important building blocks for brain tissues. Studies have indicated that AAB produce precursors of sphingolipids known as the alkali-stable lipids (ASL). Dihydroceramide is one of the alkali-stable lipids generated by AAB. Fukami and others studied the effect of ASL on dementia model rats and determined that after treatment for 10d, significant improvement sin cognitive ability occurred. Further investigation indicated that alkali-stable lipids caused greater neurite growth in pheochromocytoma (PC12) cells and dihydroceramide had the main impact. Fukami and others hypothesized that vinegar consumption might improve cognitive function in humans. Other studies found that gangliosides which were composed of sialic acid and oligosaccharides conjugated to ceramide were effective in improving Alzheimer patients' symptoms.

5.8 Antidiabetic [13, 14, 15]

Diabetes is increased glucose levels in each the state of hunger and when consumption of a meal. In type 1 diabetes, there is not enough insulin due to destruction of pancreatic cells resulting in hyperglycemia. In type 2 diabetes, insulin is present, but tissues are resistant to the insulin and therefore, blood glucose concentrations increase. Insulin sensitivity has been improved through vinegar treatment in 19% of individuals with type 2 diabetes and 34% of individuals with prediabetes. Recent studies in both animals and humans have shown that vinegar may be used for diabetic treatment. In rats, the effect of vinegar on blood sugar has been investigated and it has been reported that blood glucose decreased when compared with normal diet after ingestion of a starch load coadministered with a 2% acetic acid solution. In humans, the area under the insulin response curve decreased 20% after consumption of sucrose coadministered with vinegar. Many placebo-controlled experiments have confirmed the glucose reducing or "antiglycemic" result of vinegar. Several systems are studied to elucidate the result of vinegar on glucose concentrations. Acetic acid in vinegar avoid digestion of whole carbohydrates by either increasing intestinal transit or by increasing the uptake of glucose by tissues resulting in reduced blood glucose levels.

6. Vinegar production [2, 16]

6.1 Raw materials

The major raw materials for the production of vinegar are alcohol containing liquid, Acetobacter, a genus of aerobic bacteria, oxygen, and sometimes herbs and fruits as a flavouring agent. Alcohol Containing Liquid. Vinegar can be made from a variety of diluted alcohol products, the most common being wine and beer. Alternatively alcohol product will be prepared through carbohydrate fermentation in rice, sugar cane, or malt anaerobically by yeast. The resultant alcohol product is pasteurized, filtered and then diluted to adjust the alcohol content and then used for vinegar production.

6.2 Bacterial cultures

Acetobacter acetii cultures are used for vinegar production. These faultlessly work at a temperature of 82 °F with full air injection. The lowest temperature that the bacteria can tolerate is 20 °C (68 °F) and the maximum temperature is 91 °F. Below and above these temperatures, there is no conversion from alcohol into acetic acid. The starting alcohol should be lower than 7.5 % (v/v) and there should be no free Sulfites. In the natural processes, Acetobacters are allowed to grow over time. However, mother of vinegar is introduced as a form of Acetobacter for industrial production. Mother of vinegar is the sticky film that looks on the surface of the alcohol product because it is transformed to vinegar.

Mother of vinegar is skimmed off the upper and inserted to other batches of alcohol to increase the formation of vinegar. It consist natural carbohydrate called cellulose and this film holds the highest concentration of Acetobacters. Sometimes in the vinegar factory acetozym nutrients are added in to the alcohol liquid as a bacterial culture. An Acetozym nutrient is manmade crushed arrangement of mother of vinegar.

6.3 Flavouring agent

Herbs and fruits used for flavouring the vinegar. Commonly used herbs include tarragon, garlic, and basil. Popular fruits include raspberries, cherries, and lemons.

6.4 Processing methods

Vinegar is product obtained as an outcome of impartial oxidation of alcohol in a fermentation of sugar containing fruit or cane juice, molasses, fermented mash of malted grain, honey, syrups, etc. It is made from the fermentation of ethanol by acetic acid bacteria. The ethanol may be derived from many different sources including wine, cider, beer or fermented fruit juice. For vinegar and brew vinegar the assembly method solely includes fermentation for the

conversion of the alcohol gift within the raw materials in to carboxylic acid. However, in other types of vinegar such as fruit vinegars or cane vinegars two major processing steps are carried out; one for the production of ethanol alcohol from raw materials and the other for the conversion of the ethanol produced in to acetic acid. Vinegar contains, mainly, acetic acid by weight and small quantities of alcohol, glycerol, easters, sugars, and salts. To find pure acetic acid the vinegar is subjected to purification by distillation. The transformation of wine or fruit juice to vinegar is a chemical reaction in which alcohol undergoes partial oxidation that leads to formation of acetaldehyde. Then, the acetaldehyde is converted into acetic acid. Thus, it can be said that the production of vinegar involves two types of biochemical reactions: Alcoholic fermentation of sugar is the initial vital step within the production of vinegar and takes place beneath anaerobic condition. In this step sugar is fermented to alcohol by the action of yeast species as follows. Oxidation of alcohol to acid is the second major step in the production of vinegar and is aerobic process. In this step alcohol is oxidized to acetic acid by the action of acetic bacteria; the species of Acetobacter.

Commercial vinegar is made either by fast or slow fermentation processes. In the slow, or natural, process, vats of cider are allowed to sit open at room temperature. During a period of several months, the fruit juices ferment into alcohol and then oxidize into acetic acid. Slow methods generally are used with traditional vinegars; fermentation proceeds slowly over the course of weeks or months. The longer fermentation period allows for the accumulation of a nontoxic slime composed of acetic acid bacteria and soluble cellulose, known as the mother of vinegar. Fast methods add mother of vinegar (i.e., bacterial culture) to the source liquid before adding air using a Venturi pump system or a turbine to promote oxygenation to obtain the fastest fermentation. In fast production processes, vinegar may be produced in a period ranging from 20 hours to three days. In the modern commercial production of vinegar, the generator method and the submerged fermentation method are employed. These methods are based on the goal of infusing as much oxygen as possible into the alcohol product The three common methods used for vinegar production are the generator or trickling method, the submerged fermentation or the Acetator method and the Orleans traditional method. Traditionally natural spontaneous fermentation is also used. The Generator method is the quicker one and is generally used in commercial vinegar production.

7. Physicochemical analysis

The pH, titratable acidity and alcohol are very important parameters in the vinegar fermentation process. These parameters are used to predict the time of discharge and charge in the fermenter.

7.1 pH

pH were measured using standard calibrated pH meter.

7.2 Titratable acidity

Titratable acidity is calculated using 0.1 n NaOH solutions. Add 5ml fermented product in volumetric flask then add 5-10 ml of water in it. Add phenolphthalein as indicator and Titrate against 0.1 N NaOH. The end point will obtain at pink to colourless. Acetic acid is the major organic acid in vinegar.

The Titratable acidity is calculated by using following formula:

$$\%TA = \frac{(\text{ml of NaOH}) \text{ x } (\text{N of NaOH}) \text{ x } (60.05)}{10 \text{ x Sample Weight}}$$

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