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PRODUCTION OF VINEGAR FROM FRUIT PULP AND PEELS – A REVIEW

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Abstract: Vinegar is a sour – taste liquid that is made by fermenting the alcoholic liquids like wine, beer or cider. Vinegar is also produced from the fermentation of microorganisms like bacteria (*Acetobacter aceti)*, fungi (*Saccharomyces cerevisiae)*, etc. Vinegar can be produced by different methods and from different raw materials. Traditionally vinegar was used as a medicine to clear wounds. Later on, it is added on the pickles and known to be a preservative. Vinegar helps to kill pathogens and it is consumable when it is mixed with water or juice. Common dosages of vinegar ranges from 1-2 teaspoons mixed in a large glass of water. There are several types of vinegar made from different fruit peels, pulps, berries, etc. Natural vinegar is so effectively used as food additive than synthetic vinegar because it contains essential amino acids from the fruit source. It was reported as a medicine for aches and gastric troubles. In conclusion, Vinegar can be used as a food additive and an effective preservative against food spoilage.
Keywords: **Vinegar, *Saccharomyces cerevisiae,* Preservative, *Acetobacter aceti,* Food additive**

INTRODUCTION

Plants are autotrophic organisms that produce their own food with the help of photosynthesis. Formerly, fruits and vegetables from plants were traditionally used in the kitchen for cooking purposes. Later the medicinal importance of plants were known and used for wound healing purposes. After that anti-cancer, anti-bacterial and anti-fungal activities of some plants were studied. Vinegar is a liquid substance made from starchy and sugary materials by alcoholic and acetic fermentation [5]. Vinegar fermentation can be done in two stages, first is the Alcoholic fermentation – the anaerobic conversion of sugar to ethanol by yeast (*Saccharomyces cerevisiae)* and the second is the aerobic oxidation of ethanol to acetic acid by bacteria usually *Acetobacter aceti* [5,8]. The types of microorganisms that take part in the fermentations includes Acetic Acid Bacteria (AAB) and Lactic Acid Bacteria (LAB). Yeasts and AAB are the major microorganisms used in the manufacturing of vinegar. They can affect wine quality and fermentation speed. Yeasts are the most crucial microorganisms. The species *Saccharomyces cerevisiae* or *Saccharomyces bayanus* are the most often employed strains for making cider, and the choice of a yeast strain for the initial culture might greatly affect the flavour profile of fermented drinks [5].

The two primary ingredients in all vinegars are acid and water. Numerous nutrients, including acetic acid, lactic acid, pyruvic acid, formic acid, malic acid, citric acid, oxaloacetate, and succinate are also found in vinegar. These nutrient amounts are related to the overall total acidity content (TAC). The total acidic content in fruit vinegar is 2.4 to 3.9 pH. In other words, TAC has a strong relationship with vinegar's quality. Any product marketed as "vinegar" must comply with FDA regulations and have an acidity level of at least 4% [10]. Any sugary substance, such as sugarcane juice, jaggery, palm juices, grapes, apples and molasses, can be used to make brewed (natural) vinegar. Acetic acid is used to create synthetic vinegar, which is neither fermented nor brewed. Vinegar has also been produced using malted barley, wine (including white, red, and sherry wine), cider, fruit wines and pure alcohol.

In the temperate climate zone of the middle-latitudes, where fresh fruits are not available during the whole year, seasonal plant products are traditionally processed into preserves, such as jams, syrups, pickles, etc. An alternative means of processing fruits for culinary and health-promoting purposes, which is currently greatly gaining popularity, is vinegar fermentation [11].

The fruit vinegar is also used in manufacture of useful medicines, preservation of food stuffs, provision of antioxidants or as an antibacterial agent [4]. Salad dressings, ketchup, spicy sauce and other condiments are profoundly rely on vinegar. This needs for an industrial fermentation system that can produce a lot of vinegar. Numerous methods have been explored to enhance vinegar production in factories. The presence of acetic acid bacteria can speed up the conversion of ethanol into acetic acid. The most widely used method in the vinegar industry today is based on submerged culture and includes a number of technical adjustments (aeration, stirring, heating, etc.) that aim to improve the general fermentation conditions [3].

Vinegar is produced all over the world from a variety of raw materials, including grapes, rice, apples, other berries, cereals, whey and honey. Balsamic vinegar, manufactured from grapes, held nearly one-third of the global market share in 2005, while cider vinegar had 7%. Fruits that cannot be used to consume or average quality can be used for vinegar production. The wastage can be minimized as the vinegar is produced [14].

The FAO (Food and Agricultural Organization) has stated that 21.6% of fruits produced in the world are wasted from post-harvest distribution. Although there are alternatives, such as the manufacturing of fruit purees, juices, or even fruit jams, enormous quantities of fruit are still wasted which mediates ecological and economic consequences. One of the potential applications for leftovers from the fruit sector is the creation of macerated vinegars employing various fruit components. The peels of citrus fruits

like orange, lemon, lime, grapefruit or the complete strawberry are used for maceration with vinegar. Fruit waste is not simply used by maceration. These wastes are utilized to extract dietary fiber that can be added to other meals. The dietetic fiber made from fruits are being introduced to the market more and more due to its superior nutritional quality compared to dietetic fiber derived from cereals. The manufacturing of fruit vinegars is a popular method used by the food industry to utilize fruit by-products since it enables them to utilize surplus and subpar fruit without lowering the quality of the finished product. Almost any sort of fruit may be utilized to elaborate fruit vinegars due to their acetic nature. The acetic acid has a great sensory influence on the product's organoleptic features [12].

FRUITS AS ESSENTIAL SOURCE OF VINEGAR

Fruit wines are employed to produce fruit vinegar, which are primarily manufactured without any added flavor. Fruit vinegar frequently comes in the tastes of apple, black currant, raspberry, quince and tomato. Usually, the end product retains the tastes of the original fruits. The majority of fruit vinegar is created in Europe, where there is a massive need for sophisticated vinegar made from only certain fruits. However, Asia also produces a number of variants. Gam Sikcho or persimmon vinegar, is well-known in South Korea. In China, jujube and wolfberry vinegar are made. In India, the Jamun (or rose apple) fruit is used to make Jamun Sirka, a type of vinegar. It is said to have therapeutic use for diabetes, stomach and spleen disorders [9].

Apple vinegar is a type of vinegar that is produced using a biotechnological method of alcoholic and acetic double fermentation. Apples are one of the fruits that have been researched the most, probably because they are the second most produced fruit in the world . They are readily available throughout the year and are highly valued by customers. Numerous factors, including storage itself, have an impact on apple fruits ability to last in storage. Therefore, it is not surprising that there are many researches on the production and breakdown of primary and secondary metabolites. Many different ways to prepare samples for extraction since a wide variety of techniques have been developed to examine those metabolites. The apple peel contains high proportion of phenolic chemicals compared to apple flesh. From apple peel, secondary metabolites have been thoroughly studied [6]. Apple juice or concentrated apple juice may also be used to make vinegar. Acetic acid, which is formed through alcoholic fermentation from sugary sources, makes up 4% of the acid in vinegar. Apple wine is made by alcoholic fermentation using yeast before starting the acetic fermentation to get the appropriate amount of alcohol to make acetic acid [7].

Vinegar can also be produced from pineapple wastes. The pineapple wastes were fully converted into vinegar, which could subsequently be utilised as dressing, a food preservative and a disinfectant. The peels were diced, minced and the leftover fruit was separated before adding water to it. To change the yield, set up physical treatments to break down the fibrous structures, followed by enzyme treatments to hydrolyze sucrose and break down cellulose polymers, to which invertase was also added. With the help of sugar, starting culture, pineapple fruit and peel, vinegar was made. This vinegar showed greater antioxidant potential. So, the pineapple peel vinegar may be manufactured on a big scale and sold for its medicinal properties [2].

Acetobacter aceti is used in the bioconversion of papaya peel waste into vinegar. It showed that papaya hydrolysate's complex sugars were transformed into more straightforward fermentable sugars as a result of dilute acid hydrolysis. The yeast's amylase first breaks down the starchy residues into monomeric residues during the anaerobic fermentation. These leftovers are used to make ethanol. The total amount of ethanol discovered was 8.11%. In the end, acetic acid was created by converting ethanol to hydrate acetaldehyde, which is then converted to acetic acid by aldehyde dehydrogenase made by *Acetobacter aceti*. Vinegar from papaya peels offered a workable approach for converting a potential waste into an organic acid with significant economic value [15].

Mango vinegar was made from mango juice using a very effective and efficient procedure. The vinegar was produced with a 25% acidity level, which was comparable to commercial vinegar. When compared to industrial vinegar, the vinegar made from mango fruits had good physico-chemical qualities. Like the commercial vinegar, which was largely accepted, mango vinegar was also widely accepted by customer. Although mango vinegar can be made from mango fruits and is shelf stable for 7 months, until the procedure is improved, it might not be used for cake preservation [1].

Cashew wine is produced by alcoholic fermentation of peduncle juice. The peduncle's juice was reduced to methanol. Methanol is toxic and can cause serious consequences when consumed in excess. The maximum concentration of methanol in wine is 35 mg/100 ml. After about 48 hours of fermentation, demi-sec grade cashew wine with an alcohol content of 102.9 g/L and a saccharose content of 7.12 g/L was generated. This score was sufficient for achieving the necessary factor levels of the experimental design for examining their impacts on the productivity and yield of the fermentation process for cashew wine vinegar. The fermentation was carried out with an initial percentage of ethanol between 4.8% and 6.0% and of acetic acid between 1.0 and 1.3%, which maximized the cashew wine vinegar process. The highest productivity of 0.55 g/L/h was attained, and the yield was over 75% [13].

White grape or concentrated juice, is used to make the fragrant, aged vinegar known as balsamic, which is historically produced in the Italian regions of Modena and Reggio Emilia (typically of the Trebbiano variety). It has a very dark brown colour and a rich, sweet and complex flavour. The best grades were the results of years of age in a succession of barrels made of different species of wood, such as oak, mulberry, chestnut, cherry, juniper, ash, and acacia. In the late twentieth century, a less expensive type of balsamic vinegar became well recognised and available around the world. True balsamic vinegar was fermented for a period of 12 to 25 years. Balsamic vinegars aged for up to 100 years are available, however they are often highly costly. Commercial balsamic vinegar offered in retailers was typically prepared from concentrated grape juice blended with strong vinegar and flavoured with caramel and sugar [9].

The cultures of East and Southeast Asia are the ones that use rice vinegar the most. There have been "white" (light yellow), "red" and "black" versions of it. For making salad dressings and pho noodles, the Japanese used pale rice vinegar. Red yeast rice is typically used to produce red rice vinegar. The most widely recognized and extensively used black rice vinegar is manufactured from black glutinous rice and is exported to other East Asian nations. White rice vinegar has an uncomplicated taste and a low acidity. Some rice vinegar variants are spiced, sweetened, or otherwise seasoned with additional flavorings [9].

CONCLUSION

Various products are obtained from plants are daily used by us. One of the useful products obtained from plants is Vinegar. As the vinegar produced from natural sources also be an effective and alternate to chemically synthesized vinegar. The natural vinegar has also commercialized, widely accepted and used by various people in various regions. In order to reduce the food spoilage

or seasonal availability, fruits can be converted into vinegar and used for future purposes. Vinegar can also be used for medical purposes and it is consumable in a range of 1 – 2 teaspoons. Extraction of vinegar from peels and pulp of various fruits showed that it has pharmacological properties and can be used as a natural preseverative for foods instead of using chemicals.

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