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Review on the Effect of Fruit Wine Quality and Fermentation Conditions on the Quality of Wine

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Abstract

Fruit wine is an important part of our diet that contains essential part of vitamin and minerals that contribute to overall strength for our health. Like other beverages fruit wines are undistilled alcoholic beverages usually made from grapes or other fruits such as peaches, plums or apricots, banana, elderberry, or black berry which are nutritive, more tasty, and mild stimulants. These fruits undergo a period of fermentation and aging. They usually have an alcohol content ranging between 5 and 13%. Wines made from fruits are often named after the fruits. No other drinks, except water and milk, have earned such universal acceptance and esteem throughout the ages as has wine. Wine is a food with a flavor like fresh fruit which could be stored and transported under the existing conditions. Being fruit-based fermented and undistilled product, wine contains most of the nutrients present in the original fruit juice. The nutritive value of wine is increased due to the release of amino acids and other nutrients from yeast during fermentation. The quality of fruit wine is easily affected during fermentation due to inappropriate selection of strain for fermentation and poor management of others fermentation conditions. In this present review, I discussed, history of fermentation, initial quality of grape fruit and wine quality, fermentation stage of wine, factors influencing fermentation and wine quality.

Keywords: Fermentation; Fruits; Wine; Wine Quality; Yeast

Introduction

Fermentation is one of the oldest forms of food preservation technologies in the world [1]. Indigenous fermented foods such as bread, cheese, and wine have been prepared and consumed for thousands of years and are strongly linked to culture and tradition, especially in rural households and village communities. The development of fermentation technologies is lost in the midst of history [2]. Anthropologists have postulated or nitrogenous material is also necessary for yeast to thrive. The most common genera of wild yeasts found in winemaking include Candida, Klöckera/Hanseniaspora, Metschnikowiaceae, Pichia and Zygo saccharomyces [3].

The making of wines and beers uses this biotechnology under controlled conditions. Alcoholic beverages have been produced for centuries in various societies. They are often central to the most valued personal and social ceremonies of both modern and less literate societies. In such traditional ceremonies as child naming, marriage feasts, and funerals, alcoholic beverages are often present. In Africa, maize, millet, bananas, honey, palm and bamboo saps, and many fruits are used to ferment nutrient beers and wines. The best known being kaffir beer and palm wines [4].

Wine fermentation is one of the most ancient of human's technologies and is now one of the most commercially prosperous biotechnological processes. The technique of winemaking is known since the dawn of civilization and has followed human and agricultural progress [5]. The earliest biomolecular archaeological evidence for plant additives in fermented beverages dates from the early Neolithic period in China and the Middle East when the first plants and animals were domesticated and provided the basis for a complex society and permanent settlements. In ancient China, fermented beverages were routinely produced from rice, millet, and fruits [6]. However, in earlier years in Egypt, a range of natural products, specifically herbs and tree resins, were served with grape wine to prepare herbal medicinal wines [7]. Many of the polyphenols and other bioactive compounds in the source materials are bonded to insoluble plant compounds.

The winemaking process releases many of these bioactive components into aqueous ethanolic solution, thus making them more biologically available for absorption during consumption [8]. Using species of *S. cerevisiae* which converts the sugar in the fruit juices into alcohol and organic acids, that later react to form aldehydes, esters, and other chemical compounds which also help to preserve the wine [9]. Winemaking involves mainly three categories of operations, namely, pre-fermentation, fermentation, and post-fermentation operations [10]. In the case of wines made from grapes, pre-fermentation involves crushing the fruit and releasing juice. In case of white wine, juice is separated from the skin, whereas in red wine, the skins are not separated from the juice [11]. Clarification of juice for white wine is usually achieved by sedimentation or centrifugation. Then, yeast is added to the clarified juice to initiate fermentation. In red winemaking, the pulp, skins, and seeds of grapes are kept together after crushing and during all or part of the fermentation. This is done to extract color and flavor. Yeast is added to mashed pulp (must) in red winemaking.

Fruit wine fermentation, the conversion of hexoses into ethanol and CO_2, forms the very basis of a successful wine fermentation. The dominating yeasts present in grape must after harvest, either being wild yeast species occurring naturally on the grapes, or from commercial yeast starter cultures are responsible for this. Saccharomyces cerevisiae is the most commonly encountered species in wine fermentations for very good reason. Grape must is far from an optimal growth medium for yeast due to several stresses that the yeast is being subjected to during fermentation [12]. *S. cerevisiae* strains have however, evolved to withstand and grow in most of the stress conditions that grape must and wine fermentations offer. Slow and incomplete sugar utilization during wine fermentations is however, still a chronic problem worldwide, especially in countries with a warm climate. Incomplete fermentations are referred to as stuck, because of a residual sugar content of higher than 2 g/L in the wine after alcoholic fermentation [13].

Despite of this, the wine quality rely on the fermentation conditions such as temperature, time PH, sugar content, microorganisms and acidity. Due to this, they can be considered fermentation conditions as the only factor that can affect the wine quality. There have been several reviews in recent years about the wine quality. Most of them, however, deal with focused mostly on the effect of fermentation condition that affects the quality of wines. Therefore the effect of initial quality of grape fruits on the fermentation should be take a consideration on the quality of wines

Grapefruits, Fermentation Conditions and Quality of Wine

Initial Quality of Grape Fruits and Wine Quality

The winemaking process is a series of operations that involve harvesting grape fruits, manufacturing, and bottling the final products. The primary process of vinification is simultaneously straightforward and complex. The vinification involves viticulture, preparation of must, microbial fermentation, clarification and maturation of wine [14].

The viniculture is the cultivation of grapevines, which is a process of vines converting light energy to chemical energy. These forms of energy are stored in hydrocarbon molecules, which yield grapes with perfect balance of polyphenol, organic acids, sugar, yeast assimilable nitrogen and other organic compounds. It is a truism to say “great wine is made in vineyard” since the geographical location and climate influence the quality of the grapes [15]. Suitable grape is the primary key to produce high-quality, characteristic wine products, and the composition and quality of grapes could be influenced synergistically by species, vineyard location, ripeness and seasonal variation.

Species of Grapes and Vineyard Location: By Angiosperm Phylogeny Group (APG II) classification, grapes belong to the genus Vitis, which is one of 16 genera in the family Vitaceae. Different grape products require different characteristics of grapes, which drives the cultivation of new species. Thus, our sponsor chooses Arandell and Marquette for winemaking. The best species of grapes for wine making are Andrell and Maquette species. Arandell, a disease-resistant red wine grape with clean, berry aromas, was bred at Cornell University’s New York State Agricultural Experiment Station in 1995. Also, vines of Arandell are moderately cold-resistant, and upright growth of Arandell makes it suitable for vine management. Marquette is an outstanding wine-grape. Its resistance to low temperature, downy mildew, powdery mildew, and black rot is brilliant. Environental factors such as climate, soil condition, and other environmental conditions would influence the composition of grape; the climate of New England causes high accumulation of organic acid and low pH value. Those environmental factors would influence the metabolism of the vine so as to induce a change of berries composition. The cold climate will intervene respiration of vine, which causes excess accumulated organic acid and undesirable low pH value [15].

Ripeness of Grape: Grape ripeness is an elusive concept for many people since grape berry development and ripening is a continuous process and there is no single state. At a different stage of ripening, the various combinations of aromas, flavors, tannins, sugar and acids result in unique characters. However, winemakers have the desired grape ripeness for their distinctive wine. Thus, vineyards need to be managed appropriately to achieve the targeted ripeness and avoid overripe of grapes.

The onset of ripening happens at the end of grape growth when berries begin to soften and size increases due to cell enlargement. During this conversion process, a series of physiological changes occur in grape, while the most visible change occurs in color. Grape skin loses chlorophyll and begins to synthesize and accumulate phenolic compounds responsible for characteristic colors: yellow-gold (flavonols) and pink and red (anthocyanins) [16]. Vine starts to develop aromas and flavors, characterized by volatile aromatic compounds and non-volatile aroma precursors at the beginning of the conversion. As time advances, the sugar content of the berries increases, acidity level drops and pH increases. The changes in the tannins advances as well, which makes the grape less bitter-tasting and softer [15]. As the berries proceed to full maturity, berries size reaches the maximum, and sugar accumulation rate becomes slow. The complexity of aroma and flavor increases during the later stage of ripening (Figure 1).

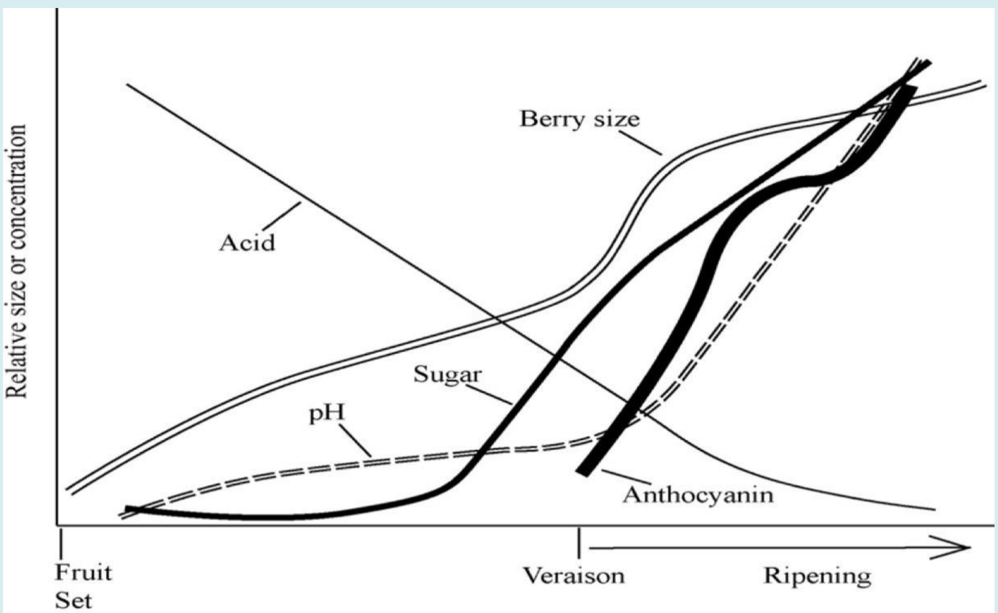

Figure 1: Generalized graphical representation of grape berry compositional changes during development and ripening [17].

Seasonal Variation: Climate has been recognized as an important factor influencing grape composition and quality of wine because of its effects on the environment and the repercussion. The impact of seasonal variation of climate would result in different harvest time, fluctuated grape sugar, and acid concentrations. Those changes lead to discrepancies of wine alcohol levels, acidities, and modification of aroma compounds. For example, hot temperatures would inhibit metabolite accumulations, which may affect wine aroma and color. High sugar concentration of must cause stress in yeast, which results in increased formation of fermentation co-product [18].

Stages of Fruit Wine Fermentation

Wine fermentation has two distinct stages: Primary and secondary (also described as aerobic and anaerobic) fermentations [19]. These fermentation stages involve complicated multistep chemical transformation of glucose to ethanol in yeast cells. While the reactions of the aerobic fermentation stage include those of glycolysis, pyruvate dehydrogenase complex, tricarboxylic acid cycle and respiratory (electron transfer) chain leading to conversion of glucose to CO_2 and H_2O, the anaerobic fermentation stage involves glycolysis, pyruvate decarboxylase complex and alcohol dehydrogenase, which converts glucose to ethanol and CO_2 [20]. Primary fermentation is characterized by 'vigorous' chemical reactions in which large volumes of gas are generated, whereas secondary fermentation is a slow and quiet reaction and is barely discernable towards the end [19].

In fermentation practice, the yields of ethanol and CO_2 that vary between 92 and 98% of the theoretical yield are attributable to the formation of small amounts of aldehydes, volatile and fixed acids, glycerol and other connecting substances, utilization of sugar for the yeasts' metabolism and small losses of ethanol during fermentation [21]. Wines also undergo Malo Lactic Fermentation (MLF) Jacobs F [19] leading to reductions in the wine acidity due to conversion of malic acid (a diprotic, dicarboxylic acid) to lactic acid (a monoprotic, monocarboxylic acid) [19]. During aging, the yeast cells die and autolyse, releasing aromatic and flavour some compounds like esters, amino acids and amides. A number of yeast species found in wine, e.g., *Saccharomyces cerevisiae, Schizo saccharomyces pombe*, *S. pombe van malidevorans* and *Zygo saccharomyces* bailii can also utilize tricarboxylic acid cycle intermediates when grown on glucose [22].

Apart from grapes, the use of tropical fruits as substrates for the production of wines has been reported. Ananascomosus (pineapple) belongs to the family Bromeliaceae. Its varieties include Cayenne, Queen, Spanish and Pernambuco [23]. Sixty percent of pineapple is edible and contains 80-85% water, 12-15% sugar, 0.6% acid, 0.4% protein, 0.5% ash, 0.1% fat, some fiber and several vitamins [24]. Pineapple is largely consumed around the world as canned pineapple slices, chunk and dice, pineapple juice, fruit salads, sugar syrup, alcohol, pineapple chips and pineapple puree [25]. It is also grown and used as a medicinal plant in the tropics because it contains a proteolytic enzyme called bromelain [26]. The therapeutic properties include treatment of malignant cell growth, thrombus formation, inflammation, control of diarrhea, dermatological and skin debridement [26]. A good quality wine has been and can always be produced from pineapple at higher temperatures, as obtained in Nigeria, than recommended because pineapple is a tropical plant [23] unlike grape which is normally grown in the temperate regions and whose wines are used as standards. Wine can be considered a food because of the caloric values of its ethanol, organic acid and sugar contents. However, its alcohol content can cause fetal damage, heart disease, cirrhosis of the liver, oesophageal, breast, colon and pancreatic cancers when abused.

Factors Influencing Fermentation and Wine Quality

Effect of Temperature on Fermentation: To avoid contamination and unpleasant odors in wine, everything that comes in contact with the wine must be very clean. This is, especially, critical when cleaning the fermenting vessel. Just as, there are weeds in the garden, also there are weeds in wines. There are microorganisms that feed on alcohol and cause a poor flavor [27]. Vinegar bacilli will change the sugar to vinegar. Molds give a stale flavor. To prevent these unwelcome intruders, cleanliness is the only answer. An effective agent is salt soda (sodium carbonate). Baking soda is fairly effective if given time to work. Either of these agents will remove odors and flavors from the containers [28]. All these chemicals may reduce the wine quality if the right quantities are not added. To avoid this situation, fruit juice for fermentation can be sterilized in stainless steel pans at a temperature of 85°C to eliminate wild yeast after extraction. The juice is filtered and treated with either sodium or potassium meta bisulfite to destroy or inhibit the growth of any undesirable types of microorganisms acetic acid bacteria; wild yeasts and molds [29]. Furthermore, increasing temperatures above 60°C may kill wild yeast and other microorganisms.

During fermentation, there are several factors that winemakers take into consideration. The most notable is that of the internal temperature of the must [30]. The biochemical process of fermentation itself creates a lot of residual heat which can take the must out of the ideal temperature range for the wine [31]. Thus, fermentation is an exothermic process. However, in winemaking, the temperature must not exceed 29.4°C for red wines or 15.3°C for white wines. Otherwise, the growth of yeast cells will stop. Therefore, a lower temperature is desirable because it increases the production of esters, other aromatic compounds, and alcohol itself. This makes the wine easier to clear and less susceptible to bacterial infection [32]. In general, temperature control during alcoholic fermentation is necessary to facilitate yeast growth, extract flavors and colors from the skins, permit accumulation of desirable by-products, and prevent undue rise in temperature that might kill the yeast cells. The low temperature and slow fermentation favor the retention of volatile compounds [9]. Red wine is typically fermented at higher temperatures up to 85°F (29°C). In most cases, fermentation at higher temperatures may have adverse effect on the wine in stunning the yeast to inactivity and even "boiling off" some of the flavors of the wines. Some winemakers may ferment their red wines at cooler temperatures more typical of white wines to bring out more fruit flavors.

Yeasts are active in a very broad temperature ranging from 0°C to 50°C, with an optimum temperature range of 20°C-30°C [33]. The temperature of fermentation is usually from 25°C to 30°C, this makes yeast an important microorganism for fermentation. White wines are fermented at 10°C-18°C for about 7-14 days. The low temperature and slow fermentation favor the retention of volatile compounds. Red wines are fermented at 20°C-30°C for about 7-14 days.

This higher temperature is necessary to extract the pigment from the grape skins [34]. With reference to other organisms, different bacteria can tolerate different temperature which provides enormous scope for a range of fermentation. While most bacteria have a temperature optimum of between 20°C and 30°C, there are some thermophiles which prefer higher temperatures (50°C-55°C) and those with colder temperature optima (15-20°C). Most lactic acid bacteria work best at temperatures of 18°C-22°C. The Leuconostocsp. Which initiate fermentation has an optimum temperature of 18°°C-22°C. The temperatures above 22°C favor the Lactobacillus sp [35]. As soon as the desired degree of sugar disappearance and alcohol production has been attained, the microbiological phase of winemaking is over. The wine was then pasteurized at 50°C-60°C. The temperature should be controlled so as not to heat it to about 70°C, since its alcohol content would vaporize at a temperature of 75°C-78°C [36].

Effect of pH on Fermentation: According to Fleet [9] pH directly affects wine stability. This may be as a result of the fact that at a pH close to neutral (7.0), most microorganisms such as bacterial and molds including some yeasts become more active for fermentation and subsequent spoilage of wine, while pH below 3.5 eliminates most of the microbes and favors only a few of the microorganisms for fermentation. Specifically, the optimum pH for most microorganisms is near the neutral point (pH 7.0). Molds and yeasts are usually low pH tolerant and are therefore associated with the spoilage of foods with low pH. Yeasts can grow in a pH range of 4-4.5 and molds can grow from pH 2-8.5 but favor low pH [31]. A solution pH is the measure of hydrogen ions (H+), concentration of an acid solution such as pineapple and grape juice or wine, or conversely, the concentration of hydroxyl ions (OH-) in alkaline solution such as lye. As the numerical value of the hydrogen ions (H+) concentration is often extremely small fraction ($1 \times 10{-7}$), the pH unit was used to express this concentration. A pH unit has been expressed as the negative logarithm of the hydrogen ion (H+) concentration, and it was determined by a pH meter [37]. From the pH scale, the lower the pH value, the higher the concentration of H+ ions, the higher the degree of acidity, thus there is an inverse relationship between decreasing pH value and increasing H+ ions concentration. For example, a wine at a pH of 3.0 is 10 times more acidic than a wine at a pH of 4.0, thus there is a ten-fold change in acidity [38]. The traditional process of fermentation involves extracting fruits juice and adjusting the pH to 4.0 using sodium bicarbonate and adding yeast nutrient (ammonium phosphate) at 0.14 g/l [39]. For example, during fermentation of fruit juice, reductions of soluble solids are possible from pH between 7.4 and 3.5 to 4.0 in worm fermentation. A pH level of 4.0 may be conducive for the development of unwanted microbes like Leuconostocoenos, and this can be prevented by controlling the pH by reducing the wine pH to below 3.2. According to Rotter, most [40] fining and clearing agents such as Earths: Bentonite and Kaolin; Proteins: Gelatine, Isinglass, Casein, Pasteurized milk, Albumen, and Yeast; Polysaccharides: Alginate, Gum arabic and Carbons; Synthetic polymers: PVPP, Silica gel and Tannins; and Others: Metal chelators, Blue fining and Enzymes are more effective in clearing the wine when the pH was below 3.5. The pH plays an important role in aging, clarifying, or fining. As the strength of the relative charge of suspended particles decreases in the wine, the pH of the wine increases. At high pH, organic protein fining agents may possess a positive charge insufficient to bind to the negatively charged particulates, thus potentially increasing the turbidity of the wine. This phenomenon is called "over fining [41].

Effect of Sugar Content on Fermentation: Sugar is the main substrate for fermentation of fruits juice into alcohol [30]. Although other food nutrients such as protein and fats can be broken down by some microorganism in some cases where sugar is limited, as long as sugar is present, yeast cells will continue the process of fermentation until other factors that affect the growth of yeast become unfavorable [42].

According to Hui [43] sugars are the most common substrate of fermentation to produce ethanol, lactic acid, and carbon dioxide. Although sugar is an important substrate of fermentation, higher sugar concentration inhibits the growth of microorganisms [44]. For example, during fermentation of the juices of the plant (*Agave americana*), the soluble solids should be at the optimum and should be reduced from between 25% and 30% to 6%; the sucrose content falls from 15% to 1%.However, yeasts are fairly tolerant of high concentrations of sugar and grow well in solutions containing 40% sugar. At concentrations higher than this, only a certain group of yeasts-the Osmophilic type-can survive. There are only a few yeasts that can tolerate sugar concentrations of 65-70% and these grow very slowly in these condition. A winemaker who wishes to make a wine with high levels of residual sugar (like a dessert wine) may stop fermentation early either by dropping the temperature of the must to stun the yeast or by adding a high level of alcohol (like brandy) to the must to kill off the yeast and create a fortified wine [45].

Effect of Microorganisms on Fermentation: For many traditional fermented products, the microorganisms responsible for the fermentation are unknown to scientists. However, there have been several researches to identify the microorganisms involved in fruits fermentation. For example, the microorganism responsible for banana beer production is *S. cerevisiae*, which is the same organism involved in the production of grape and other fruit wine. These organisms vary according to the region of production [46]. Yeast is a unicellular fungus which reproduces asexually by budding or division, especially the genus Saccharomyces which is important in food fermentations has the ability to reproduce much faster.

The most well-known examples of yeast fermentation are in the production of alcoholic drinks and the leavening of bread. For their participation in these two processes, yeasts are of major importance in the food industry. Some yeast strains are chromogenic and produce a variety of pigments, including green, yellow, and black. Others are capable of synthesizing essential B group vitamins. Although there is a large diversity of yeasts and yeast-like fungi (about 500 species), only a few are commonly associated with the production of fermented foods. They are all either ascomycetous yeasts or members of the genus Candida. Varieties of the *S. cerevisiae* genus are the most common yeasts in fermented foods and beverages based on fruit and vegetables. All strains of this genus ferment glucose and many ferment other plant-derived carbohydrates such as sucrose, maltose, and raffinose [47].

In the tropics, Saccharomyces pombeis the dominant yeast in the production of traditional fermented beverages, especially those derived from maize and millet.

Brewer's yeast, *S. cerevisiae var. ellipsoideus* and *Saccharomyces uvarumare* very common in the brewery and the wine industry. These yeasts are the microorganisms that are responsible for fermentation in beer and wine [30] .Yeast metabolizes the sugars extracted from grains and fruits, which produces alcohol and carbon dioxide, and thereby turns wort into beer and fruits into wine, respectively. In addition to fermenting the beer and wine, yeasts influence the character and flavor . The dominant types of yeast used in fermenting alcoholic beverages are the Saccharomyces sp. For example, to make beer, the ale yeast (*S. cerevisiae*) and lager yeast (Saccharomyces uvarum) are used, while in wine, *S. cerevisiae var. ellipsoideus* and *S. cerevisiae* may be used Keller [30]. Before the role of yeast in fermentation was understood, fermentation involved wild or airborne yeasts. A few styles such as lambics rely on this method today, but most modern fermentation adds pure yeast

The most common genera of wild yeasts found in winemaking include Candida sp., Hanseniaspora sp., Metschnikowiaceaesp., Pichiasp., and *Zygo saccharomyces sp*. Wild yeasts can produce high quality, unique flavored wines; however, they are often unpredictable and may introduce less desirable traits to the wine and can even contribute to spoilage [30]. Traditional winemakers, particularly in Europe, advocate the use of ambient yeast as a characteristic of the region's terroir; nevertheless, many winemakers prefer to control fermentation with predictable cultured yeast. The cultured yeasts most commonly used in winemaking belong to the *S. cerevisiae* (also known as "sugar yeast") species. Within this, species are several hundred different strains of yeast that can be used during fermentation to affect the heat or vigor of the process and enhance or suppress certain flavor characteristics of the wine. The uses of different strains of yeasts are a major contributor to the diversity of wine, even among the same grape variety [34]. According to Saranraj and Stella [45] mixture of yeast thus dual culture (*Torulaspora delbrueckii* and *S. cerevisiae*) can be used to produce a complex fruit wine from pineapple.

Yeast, in general, has a natural protein removal effect during fining or clearing. It is also sometimes used in the dried (and dead) form to remove copper sulfate, ethyl acetate, browning, oxidation, and excess oak that may be associated with cloudy wine [40]. Doses commonly recommended are 240-1000 mg/L. It is important to rack the wine soon after yeast fining to avoid reductive aromas [40]. According to Madigan and Martinko [48] homolactic fermentation can occur in some kinds of bacteria (such as Lactobacilli) and some fungi. It is this type of bacteria that converts lactose into lactic acid in yoghurt, giving it its sour taste. These lactic acid bacteria can be classed as homofermentative, where the end product is mostly lactate or heterofermentative, where some lactate is further metabolized and results in carbon dioxide, acetate, or other metabolic product [49]. Bacteria may not always be bad in fermentation; this is because to clarify the wine, the fermented juice maybe transferred into a settling vat, or if made on a smaller scale, into a demijohn. In these, suspended yeast cells, cream of tartar and particles of skin and pulp settle to the bottom of the container. As the yeast cells break down within the precipitate, they stimulate the growth of Lactobacillus sp. that converts the wine's malic acid into lactic acid. This process is, especially, important in wines made from highly acidic grapes because lactic acid was a weaker acid than malic acid (bacteria decarboxylate malic acid, thus removing the acidic carboxyl group), and therefore, it mellows the wine's taste [50].

Effect of Acid on Fermentation: Acid is said to directly affect wine quality, but wine owes its acid composition to citric acid, tartaric acid, and some traces of other acids like lactic acid which replaces malic acid during malolactic fermentation. These acids in fruits juice or wine can be determined by titration [51]. Fruit acids are weak acids compared to strong mineral acids such as sulfuric and hydrochloric. In solution, strong acids tend to yield their hydrogen ion (H+) component nearly completely; weak acids dissociate only about 1% of their hydrogen ion. Thus, such acid solutions like fruit wine have more hydrogen ions (H+) than hydroxyl ions (OH-). As hydrogen ion concentration increases, the solution becomes more unfavorable for most microorganisms associated with spoilage of wine and acidic foods.

However, some molds and yeasts which are needed in the fermentation of fruit juice into wine are usually acid tolerant, and therefore, they are very important in the production of dry wine [9]. Wines produced from grapes grown in colder climates tend to have a higher concentration of malic acid and a lower pH (3.0-3.5) and the taste benefits from this slight decrease in acidity. Wines produced from grapes in warmer climates tend to be less acidic (pH > 3.5) and a further reduction in acidity may have adverse effects on the quality of the wine. Decreasing the acidity also increases the pH to values which can allow spoilage organisms like *Leuconostoc oenos* to multiply to embark on malolactic fermentation. During fermentation of palm sap, within 24 h, pH can be reduced from 7.4 to 6.8 to 5.5 and the alcohol content ranges from 1.5% to 2.1%. Within 72 h, the alcohol level increases from 4.5% to 5.2% and the pH = 4.0. Organic acids present are lactic acid, acetic acid, and tartaric acid [52-59].

During fermentation, the pH of the wine reaches a value of 3.5-3.8, suggesting that an acidic fermentation takes place at the same time as the alcoholic fermentation. Final alcohol content was about 7-8% within a fortnight [39]. Fruit juices often have all that yeast needs all by them. Notably, grape juice is a favorite, as it has the acids, tannins, and sugars needed. Apple juice stands on its own quite well too. Other juices may need acids (not only for the yeast but also for flavor), and many commonly need tannins to be added. Yeasts are very hardy microorganisms that will get by with most fruits sugar and juices in fermentation. They can even work on plain white sugar so far as the right acid and nutrient blend are available, although this is difficult to do by most microorganisms. Acids present in wine enhance the taste, aroma, and preservative properties of the wine [46].

Conclusion and Recommendation

Conclusion

Fruits both in fresh as well as in processed form not only improve the quality of our diet but also provide essential ingredients such as vitamins, minerals, and carbohydrates. Fruit wines are undistilled alcoholic beverages usually made from grapes or other fruits such as peaches, plums, or apricots, banana, elderberry, or black current which are nutritive, more tasty, and mild stimulants. Being fruit-based fermented and undistilled product, wine contains most of the nutrients present in the original fruit juice. The nutritive value of wine is increased due to the release of amino acids and other nutrients from yeast during fermentation.

Today, wines can be made from any fruit other than grape, and the present review is a compilation of studies on wine preparation from assorted fruits. Although during the last few years, remarkable progress has been made in wine biotechnology, particularly in wine yeast improvement, development of genetically modified yeast, and lowering alcohol concentration in wine, most studies have been carried out on grape wine rather than on non-grape fruit wines. However, progress made to date and anticipated advances toward improving aroma volatiles using improved yeast strains, detailed chemometric analysis, reduction in alcohol content, in vitro and in vivo evaluation of bioactive compounds offering health benefits, and sensory evaluation should lead to wider commercialization of non-grape fruit wines, thus contributing more to the economy of the wine industry.

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