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Review Article

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Review on Development of Wine and Vermouth from the Blends of Different Fruits

Naseer Ahmed[1]*, Harmeet Chauhan[2], Babita A[3] and Prashant Bakshi[4]

[1]*Centre of Food Science and Technology, Choudhary Charan Singh Hisar Agriculture University, Haryana, India*
[2]*Department of Food Science and Technology, Sher-e-Kashmir university of Agricultural Science and Technology, Jammu, India*
[3]*Department of Fruit Science, Dr. Y.S Parmar University of Horticulture and Forestry, Nauni-Solan, HP, India*
[4]*Department of Fruit Science, Sher-e-Kashmir University of Agricultural Science and Technology, Jammu, India*

Abstract

The article presents review on prospective of wine production from various fruits, categorization of wines and current status of wine industry. Vermouth is prepared from base wine by adding mixture of herbs and spices or their extract. Different parts of various plants (herbs and spices) such as the seeds, woods, leaves, barks or roots in dry form are used. These additives are infused, macerated or distilled in a base white wine and are added at the various stages of fermentation. The liquid is filtered, pasteurized, and fortified, i.e. additional alcohol is added. Some vermouth is sweetened; however, unsweetened or dry vermouth tends to be bitter and both have different alcohol levels. It is known as aromatized liquor and it can be considered as a fortified wine. With the augment in maturation period total soluble solids, total sugar, tannins and antioxidant activity decreased while as reducing sugar and volatile acidity increased significantly in both the products. There was trivial decrease in ethanol concentration. But in vermouth titratable acidity increased and pH decreased while as in case of wine the titratable acidity decreased and pH increased. This review gives comprehensive information on the technology of wine and vermouth production, various spices and herbs used.

Keywords: Wine; Vermouth; Ethanol; Volatile acidity; Antioxidant activity

Introduction

India is the largest producer of fruit and vegetable in the world and ranks second in fruit production after china. It produces 81.29 million metric tons of fruits and ranks first in production of Bananas-22.04%, Papayas-40.74%, and Mangoes (including mangos teens, and guavas)-32.65% (NHB 2012-13). Jammu and Kashmir is blessed with diverse agro climatic conditions providing wide variety of fruits and vegetables of tropical, sub-tropical, temperate and of intermediate zone. Fruit beverages are easily digestible, healthy, refreshing, thirst quenching, appetizing and nutritionally far superior to many synthetic and aerated drinks. They are classified as Unfermented and Fermented beverages. In unfermented beverages, fruit juices do not undergo alcoholic fermentation, they include natural and sweetened juices, ready to serve beverages, nectar, cordial, squash, crush, syrup etc. [1].

Fermentation is a viable technique in the development of new products with modified physico-chemical and sensory qualities especially flavour and nutritional components. Alcohol, acetic and lactic acid fermentations are important from the point of view of quality in food production. Out of these, alcoholic fermentation is widely employed for the preparation of beverages in which alcohol is major constituent. Alcoholic beverages are classified into two main groups: Fermented soft liquor such as wine and beer and fermented distilled hard liquor such as whisky, rum, gin, vodka etc. The latter is produced through successive distillation of fermented liquor. Beer is made by fermenting cereal starch, especially barley and usually flavored with hops. It contains 4 to 11 per cent alcohol and its energy value ranges between 28 K and 73 K Cal per 100 ml. Distilled alcoholic beverages on the other hand have high energy value [2]. They are made from sugarcane juice, molasses, fermented mash of cereals and potatoes and fermented malt of barley and rye. The alcohol content of distilled alcoholic beverage ranges between 40 and 60 percent. The science dealing with wine making is known as enology. Fruit wines are undistilled alcoholic beverages which are nutritive, more tasty and mild stimulants [3]. 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 flavour like fresh fruit which could be stored and transported under the existing conditions.

Wines are the product of grape juice fermented by yeasts and subsequent aging process [4]. Fruit like apple, plum, peach, pear, wild apricot, kiwi and strawberry can also be converted into wine of acceptable qualities by the methods of Siby and Joshi, [5], Joshi et al. [6] and Sharma et al. [7]. 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 release of amino acids and other nutrients from yeast during fermentation. Studies have also shown the beneficial effects of wine consumption due to phenolics and alcohol in wine, which protects human body from free radical attack and increase HDL level in the body [8]. Sonia et al. [9] reported that 8% to 18% of ethanol (%v/v) can inhibit bacteria, yeast and mould growth but effectiveness depends upon different physical and environmental factors.

A wine containing spices and herb is called as vermouth. Vermouth is reported commercially from grapes and is of two types; Italian (sweet) and French (dry type). Vermouth has also been reported from other fruits also, like sand pear, plum and apples etc. [10]. Vermouth

***Corresponding author:** Naseer Ahmed, Centre of Food Science and Technology, Choudhary Charan Singh Hisar Agriculture University, Hissar, Haryana-125004, India, Tel: +91-9086024386; E-mail: ewsjammu@gmail.com

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is an aromatized wine having added sugar, roots, herbs, spices and flowers [11]. It contains ethyl alcohol, sugars, acid, tannins, aldehyde, esters, amino acids, vitamins, anthocyanins, fatty acids and minor constituents like flavoring compounds [8]. Vermouth can have alcohol content between 15% and 19% by volume [12]. Alcohol in the wine also stimulates gastric secretions, depresses nervous system and offer relaxation [13]. Its consumption stimulates the production of gastric juices, fosters healthy appetite, and activates the release of bile into the intestine. It has also been found to stimulate appetite in many elderly and anorectic patients. Wine has also been found as tranquillizer, diuretic; reduce muscle spasms and stiffness associated with arthritis, delaying the development of some forms of diabetes and cardiovascular disease [14].

There is abundance of tropical fruits in India which includes guava, watermelon, pineapple, plum, orange etc. These fruits are highly perishable, being susceptible to bacterial and fungal contamination, thus leading to their spoilage, mechanical damage and over ripeness. Hence, these fruits are difficult to keep for long and are utilized either as fresh or processed into juices and other specialty products [15]. High rate of wastage of these fruits especially at their peak season of production necessitates the need for alternative preservation towards their value addition that can reduce the level of post-harvest losses besides increasing diversity of products [16,17]. Although the technology of manufacturing wine from grape, apple, mango, plum juice is quite advanced, however limited information is available on the preparation of wine from other fruits like sapota, bael etc. Therefore it was thought that the production of alcoholic beverage with attractive colour and high fermentability will be one of the profitable alternatives for utilizing this fruit.

Effect of enzyme treatment on juice yield and quality

Enzymatic treatment alone or in combination with others, is one of the potential pretreatment, which results in increased yield with better juice quality, colour and acceptability. Sharma et al. [18] optimized the enzymatic process parameters for increased juice yield from carrot. They reported that enzymatic treatment resulted in increase in juice yield by 13.95% and decrease in viscosity by 0.45 cp. Singh et al. [19] reported that bael fruit juice yield, viscosity, and clarity are functions of enzymatic hydrolysis conditions. The usage of either crude or commercial enzymes significantly enhanced juice yield and clarity as compared to the control. Kaur et al. [20] optimized the conditions for clarification of guava fruit juice using commercial pectinase enzyme. Optimum conditions reported were: incubation temperature 45.35°C, incubation time 7.23 h and enzyme concentration of 0.70 mg/100 g guava pulp with ascorbic acid 77.71 mg/100 g clarity 34.54% transmittance, viscosity 1.24 cps and color (L value) 23.33.

Bahrmian et al. [21] used pectinase and cellulose enzymes for sugar extraction process from date fruits. They reported 18% increase in the amount of extracted sugars in the case of pretreated fruits by each of these two enzymes equally, while using a combination of two enzymes in proper ration and a suitable condition resulted in a further increase of sugar to about 46%, in relation to untreated samples.

While studying the effect of enzyme hydrolysis on juice yield from Bael fruit (Aegle marmelos Correa) pulp. Singh et al. [19] reported that a combination of incubation time (425 min), incubation temperature (47°C) and pectinase concentratation of 5 mg/25 g of pulp proved very benefical as far as juice yield, viscosity and clarity were concerned. The result showed that the enzyme treatment enhanced the juice yield by maximum of 17.5%. Egwim et al. [22] investigated the effectiveness of varying concentrations of pectinase on the yield of banana and paw-paw juice and reported that juice yields of 63.4% and 78.7% was obtained for banana and paw-paw as compared to 38% and 43% for non-enzymic extractions. As the concentration of the enzyme increases, the percentage yield also increases. Kaur and Sharma [23] used a combination of crude pectolytic and cellulolytic enzymes for extraction of carrot juice. They observed that the juice yield for enzyme assisted samples was found to be 71.26% as compared to control samples (59.88%). The juice yield was increased by 11.38%. Tapre and Jain [24] evaluated the effect of pectinase enzyme concentration (0.05% to 0.15%), incubation temperature (30°C to 50°C) and incubation time (60-180 min) on juice yield and clarity of banana pulp. They found that 0.11% enzyme concentration at 39.8°C, incubation for 143 min achieved maximum juice yield of 75.11% and clarity of 94.05%.

Total soluble solids (TSS)

While studying the effect of pectinase enzyme concentration and incubation time on quality attributes of durain juice Norjana and Noor [25] reported that the total soluble solids of juice increased significantly from 6.5°brix to 9.0°brix within 3 hours of incubation. Higher degree of Brix and levels of pectinase in durian juices might attribute to the greater degree of tissue breakdown which released more components that contributes to soluble solids. Mc Lellan et al. [26] also reported similar findings in apple, pears, apricots and carrot juice. When treated with enzyme, the cell walls got collapsed, separated and the nutritional components released from the interior of the cells [27]. Singh et al. [28] revealed that total soluble solid (°Brix) content of the enzyme-treated pulps slightly increases with increased incubation time from 30 min to 120 min. While studying the effect of incubation temperature (35°C to 55°C), incubation time (210 min to 540 min), and crude enzyme (0.05 - 0.15 ml/50 g pulp) concentration on juice yield of alu Bukhara. Robin et al. [29] found that the juice yield ranged between 58.1% to 79.6%. They reported that the incubation time was the most significant factor affecting the juice yield. They also observed the juice yeild increased with the increase in both time and temperature, but with further increase in temperature above 45.77°C and incubation time beyond 516.42 min, the juice yield decreased slowly which might be due to denaturation of protein which leads to decrease in enzyme activity at higher temperature. Thus they recommended the incubation time, temperature as 463 min, 45°C, and crude enzyme concentration of 0.12 ml/50 g pulp for maximum recovery of juice. Similar findings of maximum juice yield from guava is obtained by pectinolytic enzyme treatment of pulp at 43.3°C temperature for 447 min of time [20].

Egwim et al. [23] investigated the effect of pectinase on the yield and organoleptic evaluation of juice and wine from banana and paw-paw juice and reported that the pectinase treated samples of banana and paw paw fruit yields 63.4% and 78.7% and as compared to 38% and 43% for non- enzymatic treated samples of banana and paw-paw juice respectively. Response surface methodology was used to investigate the effect of enzyme concentration (500-900 ppm) and incubation time (30-90 min) on the quality of guava juice, by Akesowan and Choonhahirun [30]. They reported that physico chemical properties and yield of guava juice can be increased by adding 869.36 ppm pectinase in guava mash and incubating the same for 71.27 min before filtration yeilds 85.10% juice. The addition of pectinase caused decrease in viscosity and resulting in an ease of juice filteration. The juice obtained was high in titratable acidity, yield, total soluble solid and ascorbic acid, but low in pH and absorbance values. This can be explained that pectinase, which include pectin methyl esterase and polygalacturonase, assist in pectin hydrolysis. Their reactions caused a release of carboxylic acids and galacturonic acids which leads to a decrease in puree viscosity and pH of juice, but a significant increase in titratable acidity and juice yield [31].

Juice clarity

Norjana and Noor [25] investigated the effect of different concentration of pectinase enzyme on durian juice for juice yield, clarity, viscosity, pH, total soluble solid, and sensory evaluation and reported that the juice yield increased by 35%. They further reported that the juice treated with 0.05% enzyme concentration and incubated for 3 hours was much more preferred by panelists. Variation in juice clarity in bael fruit due enzymatic hydrolysis was studied by Singh et al. [19] and reported that the juice obtained from bael pulp was having 17.4% of juice clarity while it varied from 17.7% to 28.9% in enzymatically treated samples. They further reported that the maximum juice clarity of 28.9% was obtained at incubation temperature of 61.82°C, incubation time of 375 min having enzyme concentration of 4.0 mg/25 gm pulp which showed that enzymatic treatment enhanced juice clarity by a maximum of 11.5%. Increase in enzyme concentration may increase the rate of clarification by exposing a part of the positively charged protein molecules beneath, thus reducing electrostatic repulsion between cloud particles which caused these particles to aggregate into larger particle and eventually settle out [32].

While studying the effect of pectinase enzyme concentration (0.05% to 0.15%), incubation temperature (30°C to 50°C) and incubation time (60 - 180 min) on juice yield, viscosity and clarity of banana juice Tapre and Jain in 2014 recorded maximum juice yield (75.11%), clarity (94.05%) and pulp viscosity (372 cps) when treated with 0.11% enzyme concentration at 39.8°C incubation temperature and 143 min of incubation time.

Fermentation

Many tropical and subtropical fruits, including grapes, apples, pears, apricots, berries, peaches, cherries, oranges, mangoes, bananas and pineapples yield good amounts of juice on extraction. Upon fermentation, fruit juices can be changed into wines. However, the premium raw material for wine making has been the grape, although attempts to process other fruit wines are being made. The most frequently used non-grape fruit sources for the production of wines include apples, pears, plums, cherries, currants, oranges and various types of berries.

Graham et al. [33] treated pineapple peel with pectolytic enzyme for the production of wine and observed that the addition of pectolytic enzymes resulted in the production of the clearest wine with fruity flavour and accounted highest ratings among taste panelists for colour, clarity, flavour and aroma while untreated wine was unacceptable. Kumar et al. [34] studied the effect of dilution of Custard apple (Annona squamosa L) pulp with water in ratio 1:2, 1:3 and 1:4, were kept with and without 0.1% diammonium hydrogen phosphate (DAHP) as a source of nitrogen, for the production of wine and found that the fermentation efficiency of must was maximum 88.05% in 1:3 (pulp: water) dilution ratio along with DAHP and minimum of 79.98% in 1:2 (pulp: water) dilution ratio using no DAHP. They also reported that the overall acceptability was rated good, for the wine prepared with a dilution ratio of 1: 4 using DAHP as source of nitrogen and fair for the ratio of 1: 4 without DAHP as source of nitrogen.

Sahu et al. [35] prepared wine, from bael (*Aegle marmelos* L.) fruits, and observed that increase in titratable acidity resulted in decreased pH i.e. from 4.6 in must to 4.1 in wine. As excepted total sugar (g/100 ml) content decreased from an initial value of 12.5 in must to 2.03 in wine. Similarly total soluble solid decreased from 20°Brix in must to 2.91°Brix in wine. The decrease in total sugar content and total soluble solid from must to wine was indicative of the consumption of the sugar sources by the wine yeast to produce ethanol.

Blending

Pawar [36] prepared wine from blended juice of commercially grown grape cultivars and reported that wines developed from blended juices impart a good colour and flavour and were chemically as well as organoleptically acceptable. Patil [37] carried out studies on development of technology for pineapple wine making and reported that wine prepared by blending of Kew juice with Queen at 1:2 ratio recorded maximum pH (3.27), residual sugars (2.20%) and tannin (6.26 mg/100 g) followed by 1:1 and 2:1 ratio, whereas with respect to titratable acidity blending of Kew and Queen juice at 1:2 ratio recorded lowest value. While evaluating the preservation methods for the development of low alcoholic plum wine Gill et al. [38] blended the plum wine with 20% and 30% sand pear juice and preserved the same by conventional method and by pasteurizing at different temperatures for different time intervals using sodium benzoate and Sulphur dioxide preservatives at 100 ppm each and analyzed the beverage for various physico- chemical characteristics at an interval of 48 hrs. till 14 days. They did not find any change in total soluble solids, acidity and alcohol concentration whereas heating either at 70°C or 80°C for 10 min or 20 min, respectively, showed highest reduction in total soluble solids, increase in acidity and alcohol concentration as compared to control (without heating and any preservative). They also observed that heat treatment eliminate microorganisms thus can be used for preservation of low alcohol wine. Gupta and Sharma [39] prepared wine from juices/pulps of apple, plum and pear with honey with a blending ratio of 8:5:3 for juices/pulps, water and honey. They observed that blending of honey with fruit juices greatly accelerated fermentation rate. They found that the wines prepared from fruit honey had desirable levels of various attributes like colour, ester and aldehyde contents as compared to the honey wine. They also repoted that orangoleptically, apple honey wine proved to be the best while as plum honey wine was found to be unacceptable due to poor sugar - acid ratio.

Effect of maturation on wines

Wine is prepared by fermenting fruit juice and therefore, contains all the nutrients present in the fruit [40]. In addition, it contains alcohol, vitamins and other compounds synthesized by fermenting yeast and some compounds added during the preparation of wine.

Total soluble solids

Joshi and Sandhu [12] studied the effect of spices extract and level of sweetness on physico-chemical characteristics of apple vermouth and reported that the vermouth containing spice extract had more total soluble solids. Joshi et al. [6] prepared wine from 8 peach cultivars and reported that, total soluble solid content varied from 7.60° Brix to 9.13°Brix. Shanmugasundaram et al. [41] reported that there was no change in total soluble solid of wine prepared from banana cv. Robusta juice /pulp and the same stored for 90 days at room (28 ± 2°C) as well as at refrigerated temperatures (5°C). Patil et al. [42] studied the wine making quality of different grape cultivars and reported that the total soluble solid content of wine ranged from 5.9° Brix to 7.1° Brix. Sahu et al. [35] reported that the total soluble solids decreased from 20°Brix to 2°Brix in tendu wine. Yadav et al. [43] stored Mahua vermouth for one year and observed that the during storage the total soluble solid of vermouth increased slightly from 6.2°Brix to 6.4°Brix while as Joshi et al. [44] reported that the during maturation period of 12 months, total soluble solids content of jamun wine decreased from initial levels of 9.93°Brix to 9.20°Brix. Beera et al. [45] while screening of mango cultivars for making wine using different strains of *Saccharomyces cerevisiae* reported that in all the treatments a decreasing trend in total soluble solid was recorded after 45 days of storage which ranged from 3.00°Brix-7.00°Brix and 3.50° Brix to 7.50° Brix with *Saccharomyces cerevisiae* MTCC 172 and *Saccharomyces cerevisiae* AM 113 respectively. After 90 days total soluble solids of the same declined further ranging from 1.00° Brix to 2.00° Brix and 1.50° Brix to 2.50° Brix respectively.

Reducing sugar

Shukla et al. [46] while working on standardization of methodology and screening of jamun cultivars for wine making observed that there was reduction in reducing sugars from 0.32 to 0.18 g/100 ml. While screening the wine yeasts and juice of pomegranate cultivars for wine production. Matapathi [47] reported that the initial residual sugars of wine ranged from 2.137 (Ganesha + *S. ellipsoideus* No. 101) to 2.587 per cent (Kesar + FWY- 6) which reduced to 2.033 (Ganesha + FWY- 4) to 2.440 per cent (Kesar + FWY- 6) after 60 days of storage.

Yadav et al. [43] reported that during maturation of mahu vermouth, reducing sugars increased from 0.16% to 0.27% while as Joshi et al. [44] reported that the in jamun wine that reducing sugar increased from initial levels of 3.9 to 4.3 percent during maturation. The increasing trend of reducing sugar is apparently the results of hydrolysis of non-reducing sugar into reducing sugar during maturation [4].

Total sugars

Joshi and Sandhu [12] while working on apple vermouth reported that, the spices level (2.5% and 5%) did not alter the total sugar of vermouth. While as Sahu et al. [35] observed that total sugar content decreased from 24.55 g/100 ml in must to 3.78 g/100 ml in tendu wine. Yadav et al. [43] reported that during maturation of mahu vermouth, total sugars increased from a level of 0.27% to 0.33%. Beera et al. [45] reported that the total sugars ranged from 2.03% to 2.62% and 2.33% to 2.75% with yeast cultures of *Saccharomyces cerevisiae* MTCC 172 and *Saccharomyces cerevisiae* AM 113 respectively for different varieties of mango wine. Further storing of wines resulted a little decrease in total sugars which ranged from (1.82% to 2.37%) and (2.15% to 2.48%) with *Saccharomyces cerevisiae* MTCC 172 and *Saccharomyces cerevisiae* AM 113 respectively while as Sonar [48] prepared wine from jamun juice and reported that total sugar content of wine varied from 4.11 to 5.64 per cent.

Titratable acidity

Shukla et al. [35] reported a slight increase in acidity (0.37% to 0.38%) in peptic enzyme treated jamun wine. Joshi and Sandhu [12] while working on apple vermouth reported that, the spices level (2.5% and 5%) did not alter the titratable acidity of vermouth. Changes in titratable acidity of pomegranate wine, during storage (60 days) were studied by Matapathi [47] who found that there was a significant decrease in the titratable acidity of pomegranate dry wine. He further reported that the highest titratable acidity of 0.645% and 0.585% was recorded in wine produced from Kesar inoculated with FWY-6 on 1st day and 60th day of storage respectively. Diwan and Shukla [49] studied the effect of incubation time, inoculum concentration, and temperature on reducing sugar of fruit juice (before fermentation) on the titratable acidity of low alcoholic beverages prepared from guava and found that titratable acidity in guava wine ranged between 1.11 and 1.95 per cent. Kumar et al. [50] while evaluating the antioxidant and sensory properties of mango wine produced from eight different mango varieties under optimized fermentation conditions using *S. bayanus* and reported that the acidity of the mango wine ranged between 4.9 and 8.7 g/l (as tartaric acid) and volatile acidity ranged between 0.29 g/l and 0.58 g/l as acetic acid. Sahu et al. [35] observed that the titratable acidity (g tartaric acid/100 ml) increased from 0.85 in the must to 1.32 in the finished wine prepared from the tendu fruits while as, Yadav et al. [43] reported that during maturation of mahu vermouth, the acidity decreased marginally from 0.59% to 0.57%. As observed by Beera et al. [45] the titrable acidity of the wines produced from different varieties of mango increased significantly upon fermentation during storage which could be due to the production of certain organic acids by yeast and further storage of wine up to 90 days resulted in marked decrease in the acidity. Sahu et al. [35] prepared wine, from β-carotene rich tropical bael (*Aegle marmelos* L.) fruits, widely known for their immense medicinal properties (anti-diarrheic, anti-bacterial and anti-inflammatory) using wine yeast (*Saccharomyces cerevisiae*) as starter culture and reported that in must the titratable acidity (TA) increased from 0.08 (g tartaric acid/100 ml) to 0.15 (g tartaric acid/100 ml) in wine which was due to decrease in pH in wine. The acidic characteristic of the wine was probably due to accumulation of organic acids such as lactic and ascorbic acids, which minimizes the influence of spoilage bacteria [51].

Ethanol

While working on standardization of methodology and screening of jamun cultivars for wine making a slight increase in the alcohol content (11.23% to 11.61%) have been noticed in wines prepared by using pectinase enzyme at 0.25% in the pulp as pretreatment and have been matured for six months [46]. Changes in quality attributes during storage of Tanzanian wines were studied by Tusekwa et al. [52] who reported that storage of wines at ambient temperature for various length of time resulted in significant increase in alcohol content which ranged from 3.84 to 9.75 g/100 ml. Sharma and Joshi [53] also reported decrease in the ethanol content of strawberry wine during nine months of maturation. Qualitative changes in banana pulp and juice wine were studied by the Shanmugasundaram et al. [41] who reported that there was no change in alcohol content of wines during storage of 90 days. Kumar et al. [50] while working on the mango wine produced from eight different mango varieties under optimized fermentation conditions by using *S. bayanus* and reported that the ethanol produced in the mango wines was between 7.8% and 10.3%, and were comparable with moderate grape wines. While as Sharma et al. [54] reported that the alcohol content of Jackfruit wine ranged from 8.5% to 19.3%. Similary Sahu et al. [35] reported that the ethanol content of 6.8% (v/v) in Tendu wine. Joshi et al. [44] while studying the effect of dilution and maturation on the physico- chemical and sensory quality of jamun wine reported that the alcohol content decreased from the initial levels of 10.7% to 10.5% (v/v) after one year of ageing.

Total phenol content

Sahu et al. [35] observed that the phenolic content varied slightly between 1 g/100 ml in must to 0.95 g/100 ml in tendu wine. Kumar et al. [50] studied the antioxidant and sensory properties of mango wine produced from different mango varieties and reported that the highest phenolic content was recorded in wines produced from Alphonso (537 mg/l), followed by Banginapalli (456 mg/l) and Sindhoora (490 mg/l). Garofulic et al. [55] made an attempt to produce six types of elderberry fruit wines with addition of different amounts of sugar (0 kg, 0.5 kg, 1 kg, 1.5 kg, 1.5 kg and 0.5 kg per 4 kg of elderberry fruit) and water and reported that the total phenols in wines varied from 5136.75 mg to 8307.69 mg GAE/L. Sharma et al. [54] reported that the phenolic contents of Jackfruit wine increased during fermentation and the highest and lowest phenolic content of 7.5% mg/l and 4.3% mg/l was observed on 21st day of storage respectively.

Tannins

While standardization methodology for wine making and screening of Jambal cultivars Shukla et al. [46] reported that the tannin content of jamun wine decreased from 105 to 94 mg/100 ml. Yadav et al. [43] reported that tannin content of base wine and mahu vermouth was 0.09% and 0.32% respectively. They observed that the tannin content of vermouth decreased from 0.32% to 0.11%, after maturation for one year. Garofulic et al. [55] produced six types of elderberry fruit wines with addition of different amounts of sugar and water and observed that the concentration of hydrolyzed tannins in elderberry wines varies from 299.14 mg to 739.32 mg GAE/L. While working on apple vermouth. Joshi and Sandhu [12] reported that, the spices level (2.5% and 5%) did not alter the total tannins of vermouth. The tannin content of wines produced from different varieties of mango using with *Saccharomyces cerevisiae* MTCC 172 and *Saccharomyces cerevisiae* AM 113, ranged from 0.01 to 0.02 and 0.012 to 0.024 at 45 days of storage respectively as reported by Beera et al. [45]. They also found marked increase in tannin content during further storage. Garde-Cerdan et al. [55] studied changes in the concentration of volatile oak compounds and esters in red wine stored for 18 months and reported decrease in phenol content at the end of ageing.

Carotenoids

Sahu et al. [35] while evaluating the wine produced from tendu fruit and observed that the β-carotene content decreased from 18 μg/100 ml in the must to 8 μg/100 ml in the wine. The degradation of β - carotene was because of the physical stresses occurred during wine making such as grinding of the fruit pulp, filtration of the fruit juice, absorption by addition of bentonite, etc. [47]. Pande et al. [48] reported that the β-Carotene content of bael wine was reduced from the must (55 mg/100 ml) to the wine (33 mg/100 ml) during fermentation. While as Beera et al. [45] reported that there was a significant decrease in total carotenoids in different varieties of mango which ranged from 996 to 1872 μg/100 ml and 993 to 1864 μg/100 ml with the two yeast strains of *Saccharomyces cerevisiae* MTCC 172 and *Saccharomyces cerevisiae* AM 113 respectively at 45 days after storage. After 90 days of storage total carotenoids decreased a little which ranged from 865 to 1867 μg/100 g and 859 to 1861 μg/100 g with *Saccharomyces cerevisiae* MTCC 172 and *Saccharomyces cerevisiae* AM 113 respectively. The decrease was because the yeast might have utilized the carotenoids during fermentation. Further agening of wines of different mango varieties resulted in a little decrease in total carotenoids which ranged from 865 to 1867 μg/100 g and 859 to 1861 μg/100 g with *Saccharomyces cerevisiae* MTCC 172 and *Saccharomyces cerevisiae* AM 113 respectively. This could be due to utilization by the yeast for its survival.

Antioxidant activity

Rupasinghe and Clegg [59] studied total antioxidant capacity (TAC) using the ferric reducing ability of plasma (FRAP) assay present in ten categories of red wines and compared them with traditional wines and observed that among the wines from different fruit sources, total antioxidant capacity ranged from 219 - 2447 mg ascorbic acid equivalents/L. Total antioxidant capacity was the highest in red (Cabernet) and elderberry, blueberry and black currant wines; moderate in cherry, raspberry, cranberry and plum wines; and the lowest in apple, peach, ice wine (from grapes), white (Chardonnay) and pear wines. The total antioxidant capacity had a positive and strong correlation. Kumar et al. [50] while evaluating antioxidant properties of mango wine, produced from different mango cultivars recorded highest phenolic content of 537 mg/l in Alphonso, 456 mg/l in Banginapalli and 490 mg/l in Sindhoora wine. They also reported that antiradical activity varied from 27.57% to 36.70% ascorbic acid equivalents, the antioxidant activity varied from 73.90% to 85.95% gallic acid equivalents and the reducing power varied from 0.71 to 2.90 μm/l ascorbic acid equivalents. Sahu et al. [35] investigated the 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenging activity of the tendu wine and found that DPPH scavenging activity of wine was 52% at a dose of 250 μg/ml. The high antioxidant activity of wine might be due to the redox properties, which played an important role in adsorbing and neutralizing free radicals, quenching oxygen, or decomposing peroxides. They further reported that the DPPH scavenging activity of the tendu wine was attributed from the cumulative contribution of higher concentration of poly-phenols, ascorbic acid and β-carotene pigments present in the tendu fruit. Sharma et al. [54] reported that the maximum antioxidant activity of 36% was on the 21st day and the minimum antioxidant activity of 7.8% in jackfruit wine. Similarly, Pande et al. [58] reported that, DPPH scavenging activity of the bael wine was 48% at a dose of 250 mg/ml which was lesser than that of the must (72.4%) at the same dose.

Conclusion

Fruit wines are undistilled alcoholic beverages typically made from grapes or other fruits. 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 release of amino acids and other nutrients from yeast during fermentation. Vermouths are prepared from base wine by adding herbs and spices mixture or their extract, which impart a characteristic aromatic flavour. The quality and type of vermouth depend upon the base wine and the type, quality and amounts of various herbs/spices used.

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