Study on quality parameters of wine at opening and deterioration with time

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Abstract: Wine is an alcoholic beverage made from grapes containing alcohol ranging from 5-15% by volume. Wine consumption in the Nepalese market is gaining steady growth in recent years. In this study, parameters such as specific gravity, total acidity, pH, percentage of alcohol content, amount of total dissolved solid, presence of furfural, methyl alcohol and heavy metal were selected for analysis of red and white wine with time after the opening of the packet wine at the time interval of 15, 20 and 25 days respectively.

An increase in acidity and specific gravity (0.9780-0.9992 g/mL) while decrease in alcohol content (9.54%-8.03% by volume), presence of heavy Iron and Copper found below 0.003 and absence of furfural and methyl alcohol were observed with time. Consumption of wine in controlled amounts could prevent heart disease and circulatory problems. However, excess wine consumption can inhibit new brain cell development and depressive disorders.

Keywords: Acidity; Alcohol; Furfural; Heart disease; Wine.

Introduction

Wine is mainly composed of alcohol, organic acids, aromatics, carbohydrates, minerals, polyphenols and water. Wines may be grouped by carbon dioxide or alcohol content, color, stylistic, varietal or geographic origin[1]. Wine has been classified as still, sparkling and fortified varieties.

A wine without effervescence is called *still wine*. It contains little carbon dioxide gas, the byproduct of primary fermentation; although still wines are treated to remove carbon dioxide, there are sometimes traces of the inert gas which may be noticed as tiny bubbles. Leaving wine to mature in barrels for a couple of months or years gives *still wine*. *Sparkling wine* is technically still wine with added sparkle. Sparkling wine differs from still wine because of the significant amounts of carbon dioxide, it makes the wine fizzy. Several methods of trapping carbon dioxide are used. *Fortified wine* is still wine with an extra boost of alcohol between 14 to 23%. Fortified wine can be sweet or dry depending on when the alcohol is added. These contain additional brandy which allows wine preservation and strengthening.

There are 6 classes of red wine and 7 classes white wine depending on the physicochemical constituents involved in wine aroma[2]. *Red wines* are made from black grapes fermented along with the skin. Red wines typically have a more robust flavor. Actual color of the wine can range from intense violet (young), brick red (mature) and brown red (older)wines. The juice from most purple grapes is greenish-white; the red color comes from anthocyanin pigments present in the skin of the grape which produces a red-colored juice. *White wines* are prepared from "white" grapes, which are green or yellow in color. *White wines* are often considered more refreshing and lighter in both style and taste compared to red wine. Also due to their acidity, aroma and ability to soften meat and deglaze cooking juices, white wines are often used in cooking.

Wine has a very complex matrix of water, sugar, alcohol, and a great variety of organic and inorganic components such as phenolic, mineral, organic acids, aroma, and color-producing compounds etc., the indication of origin or variety can be possible with the use of a high number of parameters[3]. Sugars in the form of glucose, fructose or sucrose molecules present in grapes are broken into ethanol and carbon dioxide in presence of Zymase by fermentation[4]. The natural habitat might be the oak trees and the overlap of the yeast with the grape might be due to the natural habitat of grape vine climbing up the trees such as oak or the

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co-harvest of grapes and acorns[5]. Maturation of wine in oak cooperage enhances age-related color changes but temporarily augments color depth. During ageing, golden tints in white wines increase, whereas red wines lose color density. Eventually, all wines take on tawny brown shades[4]. Oak cooperage is the source of several volatile phenolic acids and aldehydes. Benzaldehyde is particularly prominent and possesses an almond-like odor. Its occurrence in Sherries may participate in their nut-like bouquet. Other important phenolic aldehydes are vanillin and syringaldehyde, both of which possess vanilla-like fragrances formed during the breakdown of wood lignins. The toasting of oak staves during barrel construction is another source of volatile phenolic aldehydes, notably furfural and related compounds. The volatile phenolic compound methyl anthranilate is an aroma component of most Vitis labrusca varieties. 2-phenyl ethanol produces the rose-like fragrance. Polyphenols are wine natural components in must and *wine* that can potentially affect the growth of lactic acid bacteria and malolactic fermentation[6].

Consumption of wine in a controlled amount could prevent heart disease and circulatory system including coronary heart disease, hardening of arteries, heart failure, heart attack, and stroke. It can also be used for preventing the decline of thinking skills in a later stage of life, Alzheimer's disease, reduce anxiety, stimulate the appetite and improve digestion. However, the use of alcohol in excess can reduce a person's life expectancy by about 10 years. It can cause higher blood pressure; increase cholesterol levels and weakens heart muscles. Long-term effects of excess wine consumption can inhibit new brain cell development and depressive disorders[7]. Many health benefits such as antioxidant, anti-inflammatory anticarcinogenic, antidiabetic, cardioprotective and hypolipidemic effects have been recognized[8].

Not only healthy food, but also moderate consumption of wine, linked to cancer prevention is associated with the consumption of antioxidants and polyphenols that are contained in wine. From the study of the clinical trials, it has been recommended moderate consumption of about 15 and 30 g/d of alcohol for healthy women and men, respectively could be protective against Type 2 diabetes, hypertension and also shows an increase in high-density cholesterol levels that could be cardio-protective[9, 10]. A study on about 1.5 million people in several countries has shown that moderate wine consumption has a reduced effect on cardiovascular risk compared with beer or spirits. However, it also involves the factors such as generic, lifestyle and socioeconomic associations with wine consumption. However, the risk increases exponentially in cardiovascular risk for heavy alcohol consumption[11, 12].

Materials and Methods

Collection of sample

A packed pouch of red and white wine of 4 L was selected and the analysis was conducted at the Laboratory of Nepal Customs Department, Tripureshwor, Kathmandu.

Color

After opening the pouch for the first time, the color was observed and the same process was repeated after the interval of 15, 20 and 25 days respectively.

Specific gravity

About 3.5 mL of the distilled sample was taken into the injection and injected into the specific gravity measuring machine. After 2 minutes, the specific gravity was displayed on the screen. A similar process was repeated after the desired time interval.

Alcohol content

From the specific gravity, the alcohol content was determined with the help of the specific gravity and alcohol content table. A similar method was repeated for the determination of alcohol content after the desired time interval.

pH

To determine the pH of the sample, a pH strip was used. By dipping the strip into the original sample, the color change was noticed and it was compared with the standard strip and the pH was recorded.

Determination of total acidity

The total acidity of the sample was calculated by titrating the distilled sample against the freshly prepared 0.05 N sodium hydroxide (NaOH). The total acid present expressed as tartaric acid and the presence of aldehyde as acetaldehyde can be calculated by using the total acidity value.

Presence of dissolved solids

In this process, first of all, a crucible and a Gooch crucible were cleaned properly and dried in the oven. After drying, the weights of both the crucibles were noted. 25 mL of the original sample was pipette out

in the gooch crucible and allowed to flow into another crucible. The crucible was then put into the oven and the content was allowed to evaporate while the gooch crucible was dried and the weight was noted. The difference in the initial and final weight indicates the amount of suspended solids in the sample.

Presence of methyl alcohol

For the methyl alcohol test, about 2 mL of distilled sample was taken in a clean test tube. A few drops of $KMnO_4$ were added to it which acted as an indicator. The test tube was kept for 30 minutes. After that Conc. Sodium bisulphate solution acidified with Conc. H_2SO_4 was added to the test tube till the solution becomes colorless. To the colorless solution acidified (with Conc. H_2SO_4) Chromotropic acid disodium salt dihydrate was added and the result was recorded. If the solution changed to colorless it indicates the absence of methyl alcohol. If the solution does not change color or appear violet color then it indicates the presence of methyl alcohol[13].

Presence of furfural

In a clean test tube, 2 mL of distilled sample was taken. Then, 2 mL of aniline was added to it. Finally, a few drops of acetic acid were added and the color was observed. The appearance of red color indicates the presence of furfural while no change in color shows the absence of furfural[13].

Presence of heavy metals

Heavy metal analysis was done with the help of an energy dispersive x-ray fluorescence spectrometer (EDX 8000 Shimadzu, Japan). The machine was switched on and it took about 8 minutes the start up. After the machine was ready, about 1 mL of the original sample was taken into the cubit and placed on the machine. It was set to the detail detection mode and after about 12 minutes the results were displayed on the computer screen and recorded. A similar process was repeated after the desired time intervals. Using the intensity of the standard samples internal calibration curve were used for the measurement of the heavy metals[14].

Results and Discussion

Color

The changes in the color of red and white wine were observed at the different time intervals are shown in the following Table 1:

Table 1: Color of red and white wine at different time interval.

Time (days)	Color	
	Red wine	White wine
1	Caramel	White with slightest yellow tint
15	Caramel with increased red tint	White with increased yellow tint
35	Brownish red	Slight cream
60	Red with increased brown tint	Whitish yellow

These observations had shown the color of White wine, white/yellow tint changes to whitish yellow color at an interval of 60 days. And the color of red wine, caramel shade changes to a reddish tint and acquired brownish color with red as the predominant color at an interval of 60 days after opening the packed pouch, this may be due to the oxidation of the wine.

Specific Gravity

The Specific Gravity of red and white wine at 20 °C observed at different time intervals is shown in the following Figure 1:

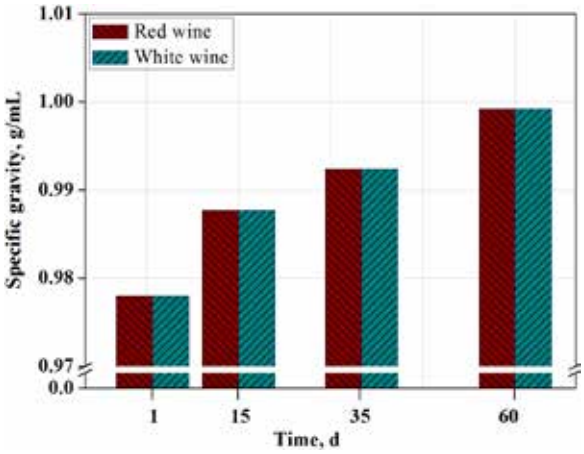

Figure 1: Variation of specific gravity with time.

The above plot shows that the specific gravity of the wine increases with the interval. It may be due to the volatile nature of alcohol and transformation into acetic acid15. The results are also supported by the increase in pH of wines with time.

Alcohol Content

The alcohol content in red wine was found more than that in white wine and was observed at different time intervals which are shown in the following Figure 2:

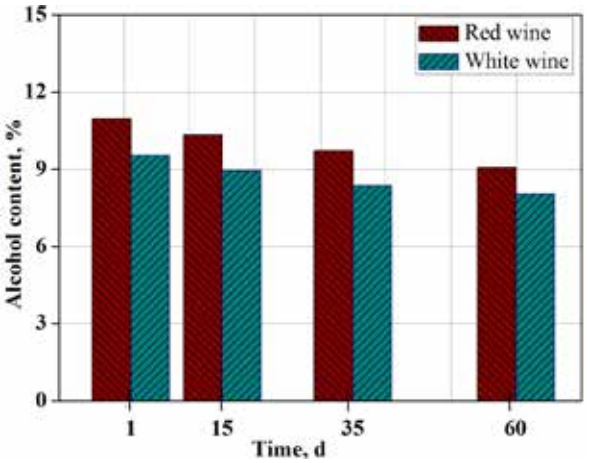

Figure 2: Variation of alcohol content with time.

The plot shows the alcoholcontent in red and white wines decreases with the increase in time intervals after opening the wine pouch. This may be due to the volatile nature of alcohol present in wine; the evaporation of alcohol content becomes higher after opening the seal. The presence of alcohol content in red and white wine is within the permissible value (7.0 -15.5% by volume)[16].

pH

The pH of red and white wine observed at different time intervals are shown in the following Figure 3:

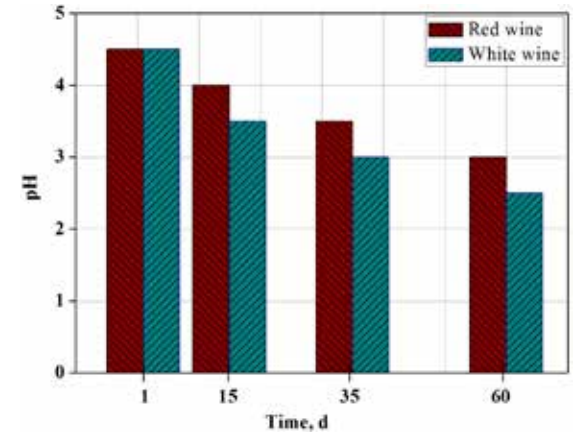

Figure 3: Variation of pH with time.

The plot shows the alcohol content in red and white wine decreases with an increase in time intervals after opening the wine pouch. This may be due to the volatile nature of alcohol present in wine; the evaporation of alcohol content becomes higher after opening the seal and air containing oxygen occupied in the container leads to the oxidation of alcohol into aldehyde and finally acid which increases the pH of wine decreasing its stability[15].

Total Acidity

The total acidity (TA) of red and white wines observed at different time intervals is shown in the following Figure 4:

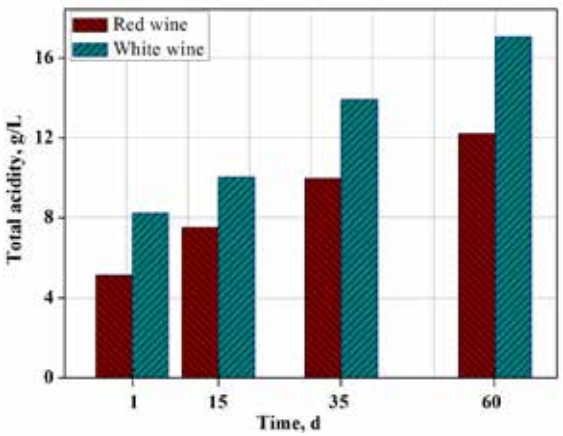

Figure 4: Variation of total acidity with time.

*pH is a measurement of the strength of the acid, while TA is a measurement of the percent by weight of acid. Total Acidity affects the taste of wine; al*though pH and total acidity are not directly related, however usually the addition of acid will lower the pH[17]. The permissible value of total acidity is less than10 g/L as per FSSAI[16], red and white wine have their total acidity value within the permissible value up to 35 and 15 days respectively after opening the pouch.

Acetaldehyde

The acetaldehyde of red and white wine observed at different time intervals is shown in the following Figure 5:

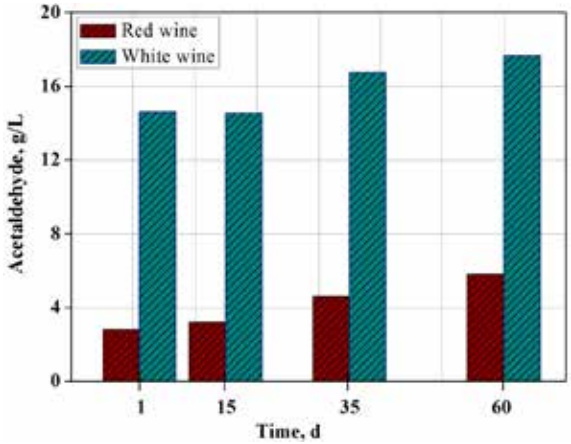

Figure 5: Variation of acetaldehyde with time.

The above plot shows the acetaldehyde concentration in red and white wine increases with the increase in time intervals after opening the pouch of the wine. Acetaldehyde is responsible for the binding sulphur

dioxide that limits the negative sensory characteristics. The sensory threshold for acetaldehyde ranges from 100-125 mg/L, However, above 125 mg/L acetaldehyde imparts pungent odors and shows a negative impact on wine quality. The maximum permissible limit for acetaldehyde is 1 g/L as per FSSAI[16].

Total Dissolved Solid

The total dissolved solid of red and white wines observed at different time intervals is shown in the following Figure 6:

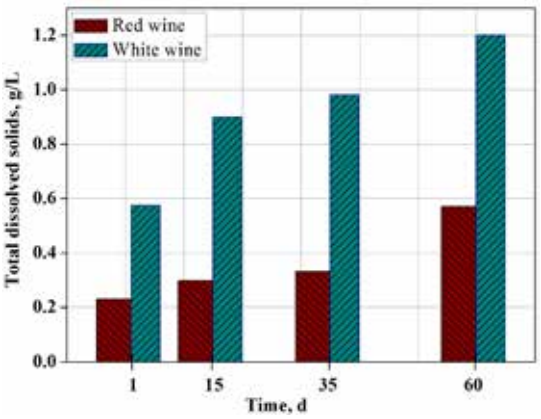

Figure 6: Variation of total dissolved solid with time.

The above plot shows that the total dissolved solid increases with an increase in time intervals after opening the pouch. This may be due to the volatile nature of wine, the dissolved solids get concentrated in the wine.

Methyl alcohol and Furfural

No methyl alcohol and furfural were observed at different time intervals of red and white wine.

Heavy metals analysis

The element iron was measured and found below 0.001 ppm in both cases of red and white wine. While the presence of Copper was detected below 0.003 and 0.001 ppm in red and white wine respectively. Other heavy metals such as cadmium, mercury, lead and arsenic were not detected at all in both red and white wine at all time intervals of analysis. The permitted value of copper and iron in red and white wine is 5 ppm. This observation shows the presence of heavy metals is within the permitted value as per FSSAI[16].

Conclusions

The color change in white wine was observed from slightest yellow tint to whitish yellow at 60th days of an opening pouch of white wine. Specific gravity at 20 °C was also found to be increased from 0.978 to 0.999. The alcohol content of the wine decreased from 9.54% to 8.02%. The concentration of total acidity increased from 8.25 to 17.07 g/L as a result of which the pH decreased from 4.5 to 2.5. Acetaldehyde increased from 14.62 to 17.65 g/L. The TDS increased from 0.58 to 1.19 g/L. No methyl alcohol and furfural were detected in the analysis.

The color change of red wine was observed from caramel to brown tint at 60th days of opening pouch of red wine. Specific gravity at 20 °C was also found to be increased from 0.978 to 0.999 g/mL. Alcohol content of the wine decreased from 10.96 to 9.05 % by volume. These observations show the volatile nature of alcohol. The concentration of total acidity increased from 5.12 to 12.22 g/L as a result of which the pH decreased from 4.5 to 3.0 Acetaldehyde increased from 2.8 to 5.8 g/L. The TDS increased from 0.23 to 0.57 g/L. No methyl alcohol and furfural were detected in the analysis. The results were found within the limited value as prescribed by FSSAI up to 15th day of opening the pouch. After that, the results exceed the prescribed limit and therefore are not suitable for consumption.

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