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QUALITY PARAMETERS OF WINE: A REVIEW

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***Abstract*—Indian wine industry growing progressively in the market. The demand for wine gradually increasing by the consumer. There is a rising trend in the demand for organic products that should not be ignored. Some parameters that determine quality in wine.The review paper aims to investigate the relationship between wine parameters and grape parameters and the impact of different process involvement that defines the quality of the wine.**

***Keywords* — Grape, Wine, Fermentation, Temperature, Tannin, sugar, pH.**

I. INTRODUCTION

Scientifically grape is known as Vitis vinifera, also known as European wine grape or common grape cultivated all over the world, and habitually used for wine production. In India, all most grapes are consumed as table fruit while 99% of grapes are used to produce wine in European countries.Especially red wine consumption is beneficial for health rather than other alcoholic beverages. Wine as a nourishing blend of nature, art, and technologies provides profitable the business of making wine in the 21st century. The awareness of quality is important to the wine industry, and wine consumers. The problems met by wine professionals in finding quality with their product, produces variable methods. The influential French oenologist, Emile Peynaud, defines one definition as 'The quality of a wine is the totality of its properties, the properties which render it acceptable or desirable'. In effect, it is the subjective pleasure provided by drinking the wine which conditions judgment [4].

II. COMPONENTS OF WINE

A grape is a combination of 75% pulp, 20% skin, and 5% seeds [5]. Water, sugar, acids, tannin, and vitamins are the main compositions of pulp. Colour, aroma and tannin are entered in wine due to skin of grape. The wine components influence qualities like taste and mouthfeel.

A) Acid

The very essential element is acid in the pulp other than water and sugar. Ripped grapes have high sugar and low acid contents, the challenge to the winemaker is to harvest surely when the ideal sense of balance of acid and sugar is revealed. Acid balances alcohol, sweetness, and a stimulating sensation. In malolactic fermentation, hard malic acid is converted into softer lactic acid. Grape'sgrown-up in cooler areas have higher acidity level.

Table 1: Desirable TA Level [6]

Sr. No	Wine Type	Titration Level
1	Red Wine	~ 0.6 to 0 .8%.
2	White Wine	~ 0.7 to 0.9 %

As shown in Table 1 white wine's TA level is high as compared to red wineso that white wine more acidic.

B) Alcohol

When yeasts come in contact of the natural grape's sugar, alcohol is introduced in the fermentation process.Alcohol is sweet in taste.High alcohol givesa burning sensation in taste. Very ripped grapes have higher level of alcohol.

Table 2: Average alcohol percentage [6]

Sr. No	Wine Type	% Alcohol	(ABV)
1	Red Wine	12% to 15%	13.5%
2	White Wine	5% to 14%	10%

(ABV) Alcohol by Volume.
The last column in Table 2 shows the average percentage of alcohol in terms of ABV. Percentage of alcohol varies on the type of wine, along with the winemaker and their desired ABV.

C) Sugar

Mature grapes have sugar, amount differs with respect to variety of grape. Sugar is transformed into alcohol during fermentation process. Left Over sugar known as residual sugar. Higher amount of residual sugar hastastessweet and have richer mouthfeel. Grapes grown in warmer atmosphere shave more sugar.

Table 3: Sugar in glass and bottle as follows [7]

Sr. No	Type	In a Glass in grams	(In a Bottle) In grams
1	Red Wine	~ 1.12	~ 4.64

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2	White Wine	~1.73	~7.2

As shown in Table 3 white wine holds more sugar as compared to a red wine.

D)Tannin

Grape's skins and seeds are responsible for tannin; it is frequently noticed in red wines but sometimes also noticed in white wines. Tannin is important parameter in wine aging. E.g., when a teabag has steeped for long time in a cup of hot tea, the tea will have a very strong-tasting, bitter (tannic) flavor which is reduced by the adding milk.

E) Water

Water is greatest element of wine pressed from the grape's pulp.

III. GRAPES CONTENTS

The quality of wine is largely dependent on the composition of the berries. Soluble solids of grape contents many organic and inorganic compounds. Grapes contents as follows-

A) Sugar

Solvable solid sugar is present in higher percentage. In the juice, main sugars are glucose and fructose. Ripe berries have sugar range in between 150 to 250 g/L. Unripe berries have glucose sugar content. Ealy stage of ripening, glucose and fructose have 1:1 proportion. In overripe berries, fructose level high. Glucose to fructose proportionis varies with respect to grape varieties.

Table 4: Residual sugar in grape [10]

Residual sugar in g/L	Residual sugar in g/100ml	Sweetness by percentage
1	0.1	0.1%
5	0.5	0.5%
10	1	1.0%

In Table 4, sugar is assessed as grams per liter of sugar or (g/L). For example, 10 grams per liter of residual sugar have 1 percent sweetness.

B) Acid

Organic acids are sufficient solids appear in grape juice. Acid provides the tart taste and its impact on wine stability, color, and pH. Tartaric, malic, and to a little amount of citric are present in grape, but tartaric and malic acid present 90% of the total acids. At berry evolution, the intensity of tartaric and malic acid rises in the berry. After maturity of berries sugar occurs in the fruit and the acid level decreases. The malic acid decreases more, and tartaric acid higher as compared to malic acid.

C) Seed and skin

Skin and seed present in higher amounts. Wine's colour and flavor define skin and seeds, also involved in aging process of wine. The phenolic substances are in the seeds and skins. White wines contain little skin and seed contact in fermentation process, phenolic content in the range of 100 to 250 mg/L gallic acid equivalent (GAE). In red wine skin and seed comes in contact of juice/must the phenolic content of red wine have range in between 1000 to 3500 mg/L GAE.

D) Nitrogenous Compounds

Nitrogen concentration increases at the time of ripping. They help as the nutrient for yeast and lactic acid bacteria, effects cell population, and production of byproducts. For wine stability, proteins (nitrogenous compounds) are used. Insufficient nitrogen in must/juice may reason for an inactive fermentation and the produce a "rotten egg" (H_2S) aroma. At the time of fermentation, the must is enhanced with Diammonium phosphate (DAP) to avoid a problematic situation. The maximum allowed DAP is 8 lbs/1000 gal or 958.7 mg/L.

E) Minerals

Minerals taken from soil into grapes and then comes into wine. The amount of minerals is near about 0.2 to 0.6% in fresh fruit. Potassium, sodium, iron, phosphates, sulfate, and chloride these minerals are present in grapes. Potassium is presents 50 to 70% in fruit. At ripening time, the potassium level increases. When fruit led to the creation of potassium bitartrate, which decreases the acidity and increases the juice pH.

IV. EFFECT OF PARAMETERS ON WINE

1) Maturity of grapes

Harvesting is a challenging viticultural decision for the grape growers due to the difficulty in judging grape maturity in the vineyard and guessing wine quality. The quality of wine is depending upon grapes. There are many characteristics of grape maturity that decide the best time to harvest the wine grapes. Characteristics of grapes are quantitative, and others are qualitative [11]. Qualitative Characteristics of grape maturity include the presence of the grapes like colour and firmness of the skins, the appearance of the stems, the colour and taste of the seeds, and grape juice and pulp. To identify the maturity of wine grapes, quantitative characteristics like total soluble solids (in °Brix), pH and acidity play a significant role. TSS (total soluble solids) is most important. Sugar content in berries not only determines maturity, but also permit winemaker to produce wines with numerous styles like very sweet, sweet, or dry having the desired level of alcohol. The more TSS content of berries gives in sweeter taste to the wine.

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2) Harvesting time

Harvesting of wine grapes starts from the end of December to the end of February depend upon cropping time. In India temperature goes very high during day hours. High temperature is responsible for a decrease in grape quality, increases the microbiological load and chances of undesirable fermentation from vineyards themselves. For making good quality wines from hot areas, it is always recommended to harvest wine grapes at low temperature. The better option is to harvest the grapes during night hours, if it is not possible during nights, harvesting grapes in the early morning hours only option for producing optimum quality wines. Many growth regulators or pesticides are being used in grape cultivation to raise its productivity and quality. Hormonal stability in any plant system is as precisely interlaced and as distinct as a spider web. Any inequity created in the hormonal system by careless usage of the growth regulators will collapse the entire plant system. So, one must use very judiciously and cautiously these growth regulators, not to cause any trouble in the gentle balance of the specific hormonal composition of the system.

3) Matter Other than Grapes (MOG)

Some non-grape materials (MOG) are present in the picking bins when cluster of grapes harvested by a hand-picked method or machine-harvested method. MOG such as leaves, leafstalks, and canes, stones, sticks, strainer wire, caterpillars, and stink bugs. MOG disturb fermentation process, depending on the which type of MOG present. Research done by Capone et al. (2018) on Shiraz wine, result observed that the presence of leaves is not contribute green flavor, stems were responsible for 'green' aroma character. Added stems gives higher astringency, colour strength, and acidity to wine[12]. AWRI helpdesk has been involved in several investigations that presence of insects and bugs in bunches during harvest are responsible for an unpleasant aroma.

4) Irrigation

Unbalanced growth, and low fruit quality is due to poor irrigation .If water to the root supplied in low quantity than the evaporative demand, then water stress can occur. Low soil moisture, high evaporation, a poorly developed root, high salt level these factors are the reason for the water stress [13]. Little shoot growth, poor flower development, flower abortion these problems are faced due to water stress. Surface drip irrigation systems used which are active rooting depth for wine grapes.

5) Aroma

Aromasare extracted from wine production process: 1. Grapes 2. Fermentation 3. Aging and maturation.

1. Grape

The aromatic compounds are existing in the skin and the layers of cells instantly under it. When the flavor is highest grapes must be harvested.

2.Fermentation

- **Aroma produced from yeast**

Quality of wine is associated with the microbial ecology of fermentation. Yeasts play important role in wine aroma by producing volatile metabolites with diverse flavor profiles.

- **Wine aroma formed during alcoholic fermentation**

Zhang et al. studies determines that maceration enzymes responsible for the creation of aroma compounds. Non-Saccharomyces species at the beginning of alcoholic fermentation may have extra ability to contribute to the freeing of some aglycons from the flavorless precursor glycoside during fermentation[14].

- **Aroma produced during amino acid metabolism**

Aroma produced from amino acids have higher alcohols and their related esters and volatile acids. Each yeast strains have different ability from another strain to use nitrogen and amino acids. Many studies determine that nitrogen supplementation in the form of as similable nitrogen and amino acids affects the volatile aroma.

- **Aroma produced during malolactic fermentation**

Lactic acid bacteria can affect the aroma by producing volatile metabolites and modifying aroma compounds derived from grapes and yeasts throughout MLF. Also, MLF can improve the fruity aroma but reduce the vegetative, grassy aroma of a wine.

3) Aging/ maturation

- **Wine aroma formed during aging and maturation**

Aroma signals can occur during wine aging, below mild acidic circumstances. Higher alcohols are important as signs for ester formation during aging. The flavor-active metabolites that have an impact on wine perception are derived from the grapes and microorganisms during fermentation, as well as from chemical processes during production and maturation.

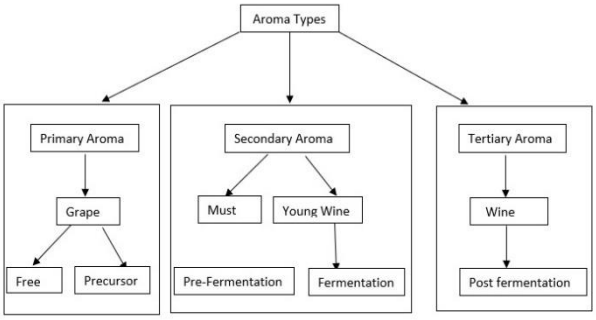

Figure 1: Classification of aroma along with wine production process

6) Acid

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The acid level in grape depending on climatic area, and cultural methods. Grapes grown in warmer climatic area have low acid level. The acidity is recognized as titratable acidity (TA). For the quality evaluation of juice and wine TA is important. Acidity and pH are closely associated with each other. However, the relationship cannot define accurately. Due to the existence some acids and their salts, the relationship among acidity and pH is a complex one. Wine maker must have knowledge of pH character in winemaking process to obtain good quality of wines

7) Temperature
All items that come in contact of wine must be very hygienic and clean to avoid infection and unpleasant odors. This is specifically serious when cleaning the fermenting vessel. Some microorganisms feed on alcohol and reason for a poor flavor. Vinegar bacilli will transform the sugar into the vinegar. Containers give a decayed taste. An active agent is a soda (sodium carbonate). Chemicals may decrease the wine quality if they are not used in the right quantities. Stainless steel pans or fermentation containers sterilized at a temperature of **85°C** to remove wild yeast. A wine can experience raised temperature during crushing, fermentation, blending, maturation, bottling, shipping, and storage. If the temperature is not satisfactorily controlled on critical control points, there is a risk to the physical, chemical, and sensory attributes that the wine can show.

Effect of Temperature on SO2
For wine preservation, Sulfur dioxide is the most used additive. It prevents the development of microorganisms and provides guards to wine against the effects of oxidative reactions (Ribéreau-Gayon et al. 2006). Temperature impacts both the SO2 balance in wine and the kinetics of oxidative reactions, in which it is involved as an inhibitor. About the balance of SO2, at a higher temperature, a greater fraction of SO2 is in the antimicrobial molecular SO2 form. Wines can be disinfected at a moderate temperature of 45–50°C, at the time of bottling (Ribéreau-Gayon et al. 2006)[16]. Similarly, the balance between free and bound bisulfite can change expressively with temperature for some bisulfite-binding compounds (but not for acetaldehyde, which is in a relatively stable bound form).

Effect of elevated temperature on volatile compounds
Flavor and aroma are questionably the most important component to perceived wine quality ecamales et al. (2011). Overall, most available studies have examined the effect of accelerated aging, encouraged by heat treatment, on the volatile profile of white wines. Some studies have measured the effect of heat treatment on aroma compounds in red wine, most likely because these wines are usually measured more resistant to the effect of temperature[16]. Robinson et al. (2010) studied the straight effect of temperature on the volatile composition of red and white wine simulated temperature situations that would likely arise during transportation, such as shipping, over 21 days. The study found that a persistent 40°C heat treatment had a greater impression on the aroma and volatile composition of the wines as compared with that of the 20°C/40°C cycled treatment, which had a greater effect on that of wines stored at a persistent 20°C. Wines that were warehoused at cool conditions (0, 5 or 10°C) were shown to have a lengthy life, retaining their young wine aromas (Pérez-Coella and González-Viñas 2003, Robinson et al. 2010).

Effect of Temperature on Must and Wine
Temperature impacts the movement of enzymes, which are existing at various points during the whole production process of wine. Enzymes are present in the grape and may disturb the aroma through oxidation and affect the degradation of the grape mash during maceration. For the metabolic processes in the living micro-organisms, enzymes are responsible, such as bacteria, yeast, and fungi. The most related species that are affected in winemaking are acetic acid bacteria, lactic acid bacteria, yeasts, and the fungus. Their activity is always affected by the temperature. Thus, the winemaker has the choice of monitoring these factors by monitoring the temperature. A temperature rises speeds up enzymatic processes. Temperatures over 37°C change the construction of enzymes and lastly lead to the decrease and removal of enzymatic activity [17].

8) Fermentation
Fermentation process effective in low-energy preservation process which rises the shelf life and reduces the need for refrigeration or another form of food preservation technology. Residual heat created in fermentation process which can take the must out of the ideal temperature range. For red wine, 29.4°C and for white wine 15.3°C temperature should not exceed [18]. Otherwise, yeast cells growth will stop.
Development of esters, other aromatic compounds, and alcohol is increases at low temperature, so it is maintained properly.
In the MLF process monitoring the progress and completion of the process is an essential quality control step in the production of red wine. By taking regular records of L-malic acid concentration, the onset and completion of MLF can be correctly determined which, additionally, allows efficient post-MLF wine stabilization (e.g., SO2 addition and possible pH adjustment)

9) Tannin
Tannin is large molecules with a molecular weight near about 500. It is appeared in yellow, brown, and red-colour. They are harsh and bitter. Tannins polymerize during wine process and aging and increases molecular size during polymerization. Smaller molecules are more bitter than astringent. In polymerization process, molecular size increases the astringency is more than the bitterness. An increase in

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molecular size makes these compounds insoluble and therefore, the wine's astringency decreases.

10) Effect of pH:

The pH is important parameters in aging, clarifying, or fining, pH directly affects wine stability. Bacteria and molds with some yeasts become more active in the fermentation process and following with spoilage of wine, pH below 3.5 allow only a few microorganisms for fermentation. At neutral point ideal pH for most microorganisms is 7.0 pH. High pH permits the growth of spoilage microorganisms. The ideal pH for dry red table wines is 3.3 to 3.6 and for dry white table wines is 3.0 to 3.4 (Rankine, 1989). Low acid in fruit and high pH rises at malolactic fermentation (MLF) may cause higher pH than the ideal pH range, that will favor microbial growth. SO2 gives effective protection against microbial spoilage and oxidation if pH is higher. Food-borne pathogens do not generally grow at pH 4.6 or below so risk of spoilage and growth of pathogens is low. Therefore, the pH in alcoholic beverages is generally adjusted below 4.6 pH value (Sperber 2009).

11) Sugar

Fructose, glucose, and sucrose are different sugar present in sweetness of wine. The order of sweetness is fructose is sweeter than sucrose, which is sweeter than glucose. For example, if a winemaker want sweeten wine, he will need less fructose than sucrose to reach the same degree of sweetness. Glucose and fructose are fermentable sugars. In fermentation, the yeast changes these sugars to alcohol and carbon dioxide. The quantity of alcohol produced is associated to the amount of sugar mainly present in the juice; thus, by adjusting the amount of sugar in the juice, one can control the amount of alcohol in the resulting wine.

12) Effect of microorganism /Yeast:

In the spoilage of foods and beverages, yeasts are responsible. Yeast is a tiny living organism that is responsible for fermentation. In alcoholic beverages, the concept of spoilage yeasthas a more complex meaning than in non fermented foods, ideal conditions in which yeast works these conditions are found in a sugary, slightly acid solution such as a fruit juice, when certain other yeast nutrients are present and when the temperature is favorable, say 65° to 75° F, (18-24° C)[22].The harmful and beneficial activity must be distinguished. Alcoholic fermentation occurs in the presence of many yeast species and bacteria (mainly lactic and acetic), it is a very tough job to draw a line between beneficial fermenting activity and spoilage activity. Hence, spoilage yeasts are rarely required during wine fermentation, when yeast levels are higher than acceptable, most wineries hold the product for long enough to meet specifications. This procedure indicates the contaminant flora because if counts increase, the wine is likely to be contaminated with spoiling yeasts. Most wineries that monitor the final product also monitor the efficiency of sanitation, the integrity of membrane filters, and the levels of sulphite and sorbate.

13) Aging

One of the most common methods in the winemaking process is aging wine in barrels and oak wood wine barrels were constructed for aging over 2000 years (Jackson, 1994). The different oak species used are Quercus alba from North America and Q. robur (also known as Q. pedunculata) and Q. sessilis (also known as Q. petraea or Q. sessiliflora) from France [22]. Oak barrels can help wines in two different aspects. One is astringency-related phenolic compounds and oak-responsible aromatic compounds are moved into wine during aging. On the other hand, atmospheric oxygen permeation through the barrel wall permits certain compounds to be oxidized moderately, which results in a decrease of astringency and changes in colour.

To produce high-quality wines, aging is an important stage in the whole winemaking process. Wine aging is a complex process including several chemical reactions. There are several aging technologies, each of which has its distinct advantages to improve wine quality and to benefit the whole winemaking industry. Among the current aging technologies, oak barrel aging has the longest history and has proved to be an efficient and reliable method to produce fine wines. Barrel aging is still the most widely used and recognized technique. Although this traditional technology has several drawbacks, such as the lengthy time needed and high cost, the traditional barrel system should not be completely abandoned. The use of wood fragments and physical methods are considered to accelerate the aging process and improve the feasibility of the process. Wood fragments provide wood-related aromas to wine whereas the application of micro-oxygenation or yeast lees improves the quality of wines both in physicochemical and sensory properties. On the other hand, physical methods, involving ultrasonic waves, gamma rays, electric fields, nano gold photocatalysis, and high pressure, have proved that they may be used for drastically reducing the aging time. Furthermore, for extending wine shelf life, ultrasound has shown certain potential in this area. Therefore, if both wood fragments and lees can fulfill their advantages during the aging process, the combination of these techniques with the physical methods above-mentioned could provide high-quality wines in a very short aging time. Finally, although a short aging time is beneficial to the winemaking industry, the quality of wine should always be considered first.

V. CONCLUSION

Wine quality defines the potentials that go into creating wine, also the characteristics that tell you if the wine is of high-level quality. Best quality wines do notcertainly need moderation in each component truly, in some cases, red wines have higher acidity while others have higher alcohol content. What makes the variance is that the other components balance things out.

Harvesting of grapes from vineyard to aging of wine in bottling different parameters are involved with the proportional manner in each process of wine to give the best quality to the wine. Wines that have an appropriate sense of balance will be of higher quality than ones where one component stands out above the rest.

VI. REFERENCES

[1]. Whfoods, Accessed: April 22, 2021 [Online]
[2]. Available:http://www.whfoods.com/genpage.php?tname=foodspice&dbid=40.
[3]. Mustali M. Dohadwala and Joseph A. Vita,Grapes and Cardiovascular Disease, The Journal of Nutrition, September 2009, Volume 139, Issue 9,https://doi.org/10.3945/jn.109.107474.
[4]. Anatoliy G. Goncharuk,THE CHALLENGES OF WINE BUSINESS IN RESEARCH, Journal of applied management and investment, November 2017.
[5]. Charters, S. J., Perceptions of wine quality, Accessed: April 25, 2021 [Online] Available: https://ro.ecu.edu.au/theses/115.
[6]. spiritswinecellar,Accessed: April 26, 2021 [Online] Available: https://spiritswinecellar.com/components-of-wine/
[7]. Binwise,JOSHUAWEATHERWAX,Accessed: April 25, 2021 [Online] Available: https://home.binwise.com/blog/wine-alcohol-content.
[8]. Binwise,JOSHUA WEATHERWAX, Accessed: April 26, 2021 [Online] Available: https://home.binwise.com/blog/how-much-sugar-in-wine#toc-is-there-sugar-in-wine-.
[9]. C.S. Du Plessis,South African Journal of Enology and Viticulture,Optimum Maturity and Quality Parameters in Grapes: A Review, volume 5,https://doi.org/10.21548/5-1-2367.
[10]. Murli Dharmadhikari, Composition of Grapes, Accessed: April 29, 2021 [Online]Available:https://www.extension.iastate.edu/wine/files/page/files/compositionofgrapes.pdfwinefolly,Accessed:April 30, 2021 [Online] Available:https://winefolly.com/deep-dive/sugar-in-wine-chart/
[11]. J.Sharma, A.K. Upadhayay,Nutrian and water management, Good Agricultural Practices for Production of quality Table Grapes,Published by National Research Center for Grapes,Pune,
[12]. Awri, Accessed: May 1, 2021 [Online] Available: https://www.awri.com.au/industry_support/winemaking_resources/winemaking-practices/winemaking-treatment-matter-other-than-grapes-mog/
[13]. Allen Hamman, Jr, Imed Eddine Dam, Effects of Irrigation on Wine Grape Growth and Fruit Quality Richard,Research Report of Hortechnoly, January–March 2000.
[14]. Antia G. Pereira and Maria Fraga and Paula Garcia-Oliveira and Maria Carpena and Cecilia Jimenez-Lopez and Catarina LourenÃ§o-Lopes and Lillian Barros and Isabel C.F.R. Ferreira and Miguel Angel Prieto and Jesus Simal-Gandara, Management of Wine Aroma Compounds: Principal Basis and Future Perspectives,Chapter 3, Chemistry and Biochemistry of Winemaking, Wine Stabilization and Aging, IntechOpen publisher,2021
[15]. Pazhani Saranraj, Panneerselvam Sivasakthivelan , Murugadoss Naveen.Fermentation of fruit wine and its quality analysis: A review,Australian Journal of Science and Technology, December 2017.
[16]. N. SCRIMGEOUR, S. NORDESTGAARD, N.D.R. LLOYD, and E.N. WILKES ,Exploring the effect of elevated storage temperature on wine composition,Austrelian Journal of Grape and Wine Research, December 2015,http://dx.doi.org/10.1111/ajgw.12196.
[17]. Maik WERNER, Doris rauhut,temperature control in winemaking,internet journal of enology and viticulture, 2009, Nº9/1, State Research Institute Geisenheim, Germany..
[18]. Awri,Accessed: May 1, 2021 [Online] Available: https://www.awri.com.au/wp-content/uploads/2020/09/MLF-in-red-wine.pdf.
[19]. Awri,Accessed: May 1, 2021 [Online] Available: https://www.awri.com.au/industry_support/winemaking_resources/fining-stabilities/microbiological/avoidance/.
[20]. Riikka Juvonen, Vertti Virkajärvi, Outi Priha & Arja Laitila,Microbiological spoilage and safety risks in non-beer beverages,January 2011, 0.13140/ RG.2.1.3166. 8562
[21]. Loureiro V, Malfeito-Ferreira M. Spoilage yeasts in the wine industry. Int J Food Microbiol. 2003 Sep 1;86(1-2):23-50. doi: 10.1016/s0168-1605(03)00246-0. PMID: 12892920.First step in wine making by By C. J. J. BERRY.
[22]. Tao Y, García JF, Sun DW. Advances in wine aging technologies for enhancing wine quality and accelerating wine aging process. Crit Rev Food Sci Nutr. 2014;54(6):817-35. doi: 10.1080/10408398.2011.609949. PMID: 24345051.
[23]. JJ Buckley Fine Wines,Accessed: May 3, 2021 [Online] Available: https://www.jjbuckley.com/wine-knowledge/blog/the-4-factors-and-4-indicators-of-wine-quality/1009#:~:text=The%20five%20components%20%E2%80%93%20acidity%2C%20tannins,need%20to%20reach%20optimal%20balance.