



Modern Technologies in Winemaking Process

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ABSTRACT

Modern technologies are a close association between humans and machines. Grapes wine is popular mostly in the world due to the demand, wine industries are established in India and export wine to other countries. Modern technologies are used to fulfill demand, and a lot of new technologies and applications are invented in a few years. This paper's objective is to overview different modern technologies that are used to speed up production time and labor costs. Modern applications are carried out harvesting, fermentation of must, clarification, and aging of wine at a single endpoint. Technology provides a centralized data system and gives smoothness to an operation that is carried out in each phase of the winemaking process.

Keywords: Fermentation, Crossflow filtration, Harvesting, Wine, Expert system

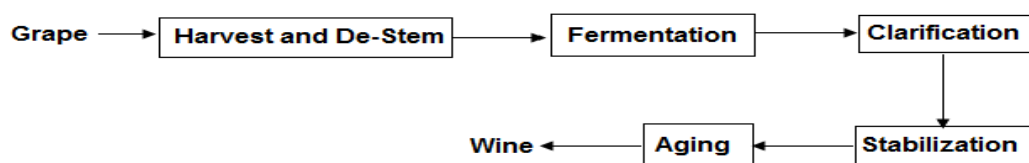
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INTRODUCTION

In India, fruit production is done in large quantities, and the market demand for fruits is also high. Fresh fruits are also an important food in India. Post-harvesting and harvesting techniques lose their quality sometimes and due to this, farmers face lots of economic problems. Post-harvesting fruits are used by the preservation industry and applying the fermentation process on these fruits produces wine. There are different types of red wine, white wine, apple wine, mango wine, etc. Conventionally winemaking process is straightforward (destem grapes, fermentation, clarification, aging) but different countries' winemaker has their own approaches and certain method to get the finest quality wine. Certain procedures offer the highest chances of success, but also something goes wrong which spoils the whole process and experienced the financial loss.



The high competition in the winemaking industry requires innovative and optimization techniques that produce wines with high-quality standards that satisfy the demands. Nowadays modern technology has resulted in enhancements to the process of winemaking such as better-quality control, greater consistency, and best accuracy. In a traditional winemaking system, a human expert plays a very important role, takes a decision in each step, and deals with sudden changes faced in the process. Human expert's different decision offers different techniques which affect wine quality. The winemaking process is complex for decision-making, sometimes human expert decisions are differing from each other decisions. Modern technologies overcome ambiguities and gives appropriate decisions for end users all the time.

Modern Technologies in Wine Making

Industrial technology includes instruction in optimization theory, human factors, organizational behavior, industrial processes, industrial planning procedures, computer applications, and report and presentation preparation. Industrial technology is the use of engineering and manufacturing technology to make production faster, simpler, and more efficient.

Harvesting

Harvesting grapes early will produce wine with higher acidity, lower alcohol, and more green flavors and aromas. It could also give more bitter tannin. Harvesting grapes later in the harvest season will produce wines with lower acidity, higher alcohol, and more tannin. Some wines are artificially acidified because of late harvesting. In Old days growers use manpower in the vineyard which was labour expensive and time-consuming process but due to competition in the global and local markets growers had to seek new mechanized vineyard operations. Last few years, new technologies have been implemented that allow automation in the vineyard, technologies like robotics, remote sensing, and wireless sensor networks (WSN). Modern agricultural machines use automation technologies to control the operation within the vineyard (in terms of speed and direction of travel and steering angle) and to manage agriculture operations.[5] Precision viticulture includes global positioning systems (GPS), meteorological and other environmental sensors, satellite and airborne remote sensing, and geographic information systems (GIS) to assess and respond to unpredictability. Precision viticulture systems in the vineyard manage operations like soil fertility, fertilizer application norm, disease, water, weed, harvesting, and environmental management.

Reis et al. (2012) state that one of the most challenging operations in winemaking is harvesting, grape detection is a difficult job for a human, especially when the grapes and leaves have a similar color, which is commonly found in the case of white grapes. They proposed a system for the detection and location, of bunches of grapes in color images. The system differentiates white and red grapes, and at the same time, it calculates the location of the bunch stem. The system gives correct classifications for red and white grapes 97% and 91 respectively. [6] Many machines are existing, and technology is advancing fast to speed up the harvesting time of the grapes harvest more delicately with less harm to the bunches. There are currently two types of harvesters available on the market, such as self-propelled harvesters and towed harvesters (Figure 1) [7] E.g. The Grapes'Line towed harvester PELLENC innovations include all the latest functions. Harvesting capacity identical to a self-propelled harvester, Destem and sort your harvest in the field to go directly into the tank.



Fig.1 towed harvester Source: Pellenc

Fermentation

Fermentation is the most important phase of the winemaking process there are different factors affecting the fermentation process like (temperature, punch over and punch down method, sugar level, time to press must, clarification, etc.) An expert system can monitor all the important fermentation activities and accurate results to the end user. Human expert decisions are varying from person to person but with the help of an expert system, we get appropriate results all the time. By using historical data expert system is programmed with dataset values and monitors the winemaking system.

E.g. 1) "Smart Winery: A Real-Time Monitoring System for Structural Health and Ullage in Fino Style Wine Casks" by Eduardo Canete, Jaime Chen, Cristian Martin ID, and Bartolome Rubio presents that, Smart cork is placed on the wine cask, it gets information from casks and interconnect with IoT architecture to transmit data from cask to cloud platform and notify the operator about fermentation process[9].

2) Anton Paar company developed FTIR wine analyzer Lyza 5000 wine is a solution for the analysis of wine, must, and must in fermentation. This machine gives fast measurements for a multitude of

parameters to ensure you have all the information you need during all steps of wine production. It gives all-important results for wine analysis, including ethanol, sugars, and acid profile are just a tap away. Another one is Alcohol Meter by Anton Paar reliably and accurately determines the alcohol content in a wide range of alcoholic beverages all types of beer and beer mixtures, wine, cider, spirits, and liqueurs, but also fermenting grape juice, wort, molasses, and wash. The variety of the alcohol meter portfolio – ranging from portable instruments for quick checks to our lab systems with outstanding accuracy and user support – ensures individual solutions tailored to your needs.



Fig.2FTIR Wine analyzer Lyza 5000 wine Sorce: Anton Paar



Fig.3Alcohol Meter Sorce: Anton Paar



Fig.4WineScan™ SO2 sorce: Foss

3) Foss Company also developed a WineScan™ SO2 wine analysis machine for winemakers and laboratories. It has full control of the entire winemaking process. Analyze +20(including Ethanol, sugars, organic acids, pH, color, free and total SO2.) parameters in 30 seconds. Convenient sulphite analysis in just 2 minutes. Low cost per sample. Intuitive operator interface. It has different sample types like Must, must under fermentation, finished wine, and sweet finished wine.

Clarification and stabilization:

Nowadays in the wine industry crossflow microfiltration replaces the traditional filtration techniques. Crossflow filtration is a ‘soft’ process because the filtering is made without any modification of the state of the filtered component, and not ever gets distorted. Crossflow filtration custom with selective porous membrane that filters a liquid to purify or clarify it. While in dead-end filtration the circulation of the liquid is not perpendicular to the filter (as in cartridges, plate filters, etc), in crossflow filtration the circulation is parallel to the membrane. The technique consists of creating a turbulent stream on the surface of the membrane, thus preventing filtered particles to settle on the membrane. crossflow filtration clarifies the wine, giving it a clear appearance and making the wine microbiologically stable.

Youssef El Rayess, and Martine Mietton-Peuchot overview “Membrane Technologies in Wine Industry: An Overview” paper, membrane technologies used in the wine industry. Membrane-based processes in

performance plays important role in the field of separation/purification, clarification, stabilization, concentration, and de-alcoholization of wine. They also state the advantages of CFMF (crossflow microfiltration) over traditional techniques that clarification, microbiological stabilization, and sterile filtration that are followed in only one continuous operation, reduce wine loss, are highly automated processes, and improve hygiene and work safety [8].

E.g. 1) The Tangential Integrated System (TIS) is an autonomous module that integrates the housing, the membranes, the circulation loop, and the pump, creating a tangential flow. In 2005, SIVA developed a new TIS to optimize and develop new crossflow filtration processes, and the company's R&D team has created a new generation of TIS VINI-TIS.

2) PALL company designed Oenoflow XL-E systems to full fill the needs and requirements of small and mid-size wineries. This system enables post-fermentation clarification of wine in a reliable, economical, and single process step. Clarification is achieved without the need for filter aids, centrifugation, or a significant impact on the organoleptic characteristics of the wine. The system utilizes Pall's proven high area, hollow fiber membranes with unique mechanical strength, and excellent chemical resistance which allow high productivity and repeated exposure to aggressive cleaning regimes. When coupled with user-friendly software with cycle programming and a compact footprint, the XL-E series is the easy solution for wine clarification.



Fig.5 Oenoflow XL-E source: PALL



Fig.6 VINI-TIS Source: SIVA

Aging

Wine aging is a desirable and valuable process, commonly used to improve wine quality, and traditionally carried out in oak wooden casks. The correct use of oak barrels and the ever-increasing demand for barrels in the different production areas of the world has led to a constant search for technological alternatives to reproduce the chemical and physical processes undergone by wines during their stay in barrels.

E.g.1) "Device for Accelerated Aging of Wine", the system was developed by Ronald C. Stites, Erik J. Stites, David Gill, Andrew Benwell, and Stephen, M. Stites, from Colorado, Utah, California, and Missouri. The patent was filed on December 29th, 2014, and was granted and published on July 2nd, 2015.

They invent a small, portable DC (direct current) device that could be used in changeable volumes of wine. By using DC current, the inventors were able to produce a small enough device to be able to suit for a bottle or a glass of wine, and lessen the amount of voltage used, energy lost, and heat produced. Device works are that you would select the volume of wine that you want to age, stick the positive and negative electrode end into the wine, flip the switch so electricity flows into the wine thus creating free radicals, and then treat the wine for a certain time (between 1 and 60 minutes) to achieve the desired "aged" level of the wine. This low voltage current creates free radicals, which then react with the compounds in the wine and precipitate out the tannins and other polyphenols that are responsible for creating the acidity taste/feeling in the wine[10].

Taste wine with AI

Wine quality depends on different factors like grapes production, the winemaking process, and the aging of wine. For wine tasting, you first examine a glass of wine with your eyes, by holding the glass up to the light. You then smell the wine to get a sense of its overall flavor profile. Then, you sip the wine, activating your sense of taste. To taste the wine quality chemical data is not enough to define parameters so that to taste the wine quality sensory glasses are designed. "Application of Neural Networks to Identify Wine Based on Electronic Tongue" in IEEE Pacific-Asia Workshop on Computational Intelligence and Industrial Application 2008 by Hong Men, Weiguang Wang, Zongnian Ge, Jianping Sun they presented a Taste sensor designed to categorize different tastes made up of selected sensor array, signal processing, and pattern recognition algorithm. The sensor array detects signals processes signals and sends them to pattern recognition algorithms to identify the taste[11]. A multi-sensory experience that some wine brands might be able to re-create in the future, with Virtual Reality (VR) technology. Brancott Estate Wines in New Zealand created one showcase experiment for VR. The winery created a virtual wine tasting experience that perfectly captured the sights, sounds, and yes, smells, of what it would be like to taste wine in New Zealand[12].

CONCLUSION

This paper aims to review modern technologies in the field of the winemaking process. In recent years, technologies had rapid development and greater applicability due to lesser costs, comfort of use, and usefulness. Automation in the vineyard perform all agricultural operation and harvest grapes on time and gently from the vineyard. Fermentation with new techniques monitors the fermentation process with different systems. Clarification with crossflow filtration TIS techniques pumps installation not off if something goes wrong in the process, it requires low consumption of water and cleaning agents. Aging of wine with technical support always gives constant parameters and accurate results on each volume of wine every time. In general, modern technologies are solutions for cost reduction in wine production and fulfill wine demand in the market in this competitive world of wine.

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CONFLICT OF INTEREST

The authors have no conflict of interest.

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