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THE DIFFERENT ANALYTICAL METHODS USED TO DETERMINE THE WINE ANTIOXIDANT PROPERTIES: A REVIEW

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ABSTRACT

The electrochemical methods used to determine the antioxidant properties and total phenolic content in wine are presented in this review paper like voltammetry, potentiometry, mass spectrometry, chromatography, and electrochemical sensor. To detect and measure the antioxidant activity of wine developed many analytical methods to present an easy, fast response and inexpensive systematic approach used in the field. Electrochemical sensors are the best tools for antioxidant properties determination in the research field. The electrochemical sensor has elevated sensitivity, simplicity, fast response time, and best efficiency. These sensors are used for different purposes with a limited ability to emphasize the advantages and distinguish between them. Quantification of specific antioxidants or total antioxidant content using electrochemical sensors has been analyzed. This summary proves the reliability of the electrochemical sensor.

Keywords: Antioxidant, Wine, Indicators.

INTRODUCTION

The alcoholic beverage wine is a composite mixture of water, ethanol, amino acids, phenolic compounds, sugars, pigments, and trace metals [1-4]. The phenolic content present in wine depends on many factors such as the variety of grapes (green or black), viticulture, winemaking techniques, and environmental effects like temperature, pressure, type of soil, and aging processes [5-8]. However, other factors such as alcoholic fermentation, maturation, pressing, and fining process also appear to influence the phenolic composition of wines [9]. During wine production, and especially during aging, various chemical reactions occur that are exclusively responsible for changing the antioxidant activity of wines due to the phenolic content [10, 11]. Recently, the field of studying wine's capabilities, beverages, and supplementary foods to prevent the disease which caused by free radicals has gained attention due to their interesting properties [12]. The remarkable health-enhancing properties of wine and other alcoholic beverages are associated with the occurrence of phenolic-containing compounds that show elevated antioxidant properties [13]. Given the large health benefits associated with the human diet, wine and other alcoholic beverages play an important role as dietary antioxidants. Previous studies have shown that the consumption of little amounts of red wine regularly, reduces the risk of artery-related disease, platelet aggregation, headache, consciousness, and certain forms of cancer [14].]. Red wine is a rich source of phenolic compounds with a wide range of biological activity, including flavonoids, gallic acid, resveratrol, phenolic acids, polymeric proanthocyanidins, anthocyanins, oligomeric, and many other polyphenols.The bioactivities such as anticarcinogenic, antiviral, cardioprotective, anti-inflammatory, and antibacterial properties of wine are believed to be mainly supported by antiradical and antioxidant activities [15, 16]. The phenolic-containing compounds also contributed to the pleasantness and sensorial uniqueness of the different types of wines like red and white etc. The phenolic content in wines differentiate the quality of wines, it is also a widespread homogeneous sign to estimate the most excellent worth of wine [17, 18]. Easy, simple, less pricing cost, sensitive and accurate methods for determining the antioxidant properties of wines related to their phenolic content are given below.

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DIFFERENT ANALYTICAL METHODS USED TO DETERMINE THE WINE ANTIOXIDANT PROPERTY ARE GIVEN BELOW

Folin -Ciocalteu (FC) Method

This technique employs supernatural detection based on spectra. While the Folin-Ciocalteu Reagent (FCR) is reduced when it react with the phenol and generate molybdenum tungsten blue, which is quantified by visible spectrophotometer at the 750 nm, this is a practical and straightforward technique for determining the overall phenolic content in wine. Although molybdenum tungsten blue is limited by the lack of an environmentally acceptable reagent and a lengthy processing time, its intensity rises proportionally to the amount of phenol in the reaction media [19].

DPPH Method

The antioxidant value measured in the wine samples was determined by spectrophotometric methods. A 0.5ml aliquotofeachsamplewascombinedwith1mlDPPH add with methanol (15 mg/100ml).The absorbance was measured after 20 minutes at 516nm. Results are accessible in the g/l gallic acid equivalent [20, 21]. But this method has some drawback; it is chemically not handled easily and long processing time.

ELECTROCHEMICAL BIOSENSORS FOR DETERMINING ANTIOXIDANT ACTIVITY

It is becoming more and more important and necessary to use novel materials in biosensors since, their performance improved in terms of specificity, generatively and sensitivity. Electrochemical biosensors, which are based on the redox reaction principle and assess antioxidant activity, have many benefits over the conventional type methods which are frequently calculated first screening of antioxidants. Technological approach doesn't require the use of any special sample preparation, complicated solvents, or chemical reagents. It offers thorough and reproducible information on electrodynamics processes as well as the ability to achieve reliable results quickly. The HRP based biosensor that was outlined utilized the earlier studied was utilized in this one. The prior experiment and this one were strikingly similar. The abilities of the extracts antioxidant were investigated using the DPPH method. Amount of phenolic chemicals present was strongly interrelated with the overall antioxidant activity of the extracts, with a correlation coefficient of more than 0.90. The results were presented in conditions of the qualified antioxidant activity of several Yerba companion extracts from various origins.

Table 1: Numerous Examples of Enzyme-Based Biosensors used in Different Matrix.

Receptor	Strategy	Detection Method	Target Molecule	Linear Range (μM)	LOD (μM)	Matrix
Tyrosinase	Entrapment with water-soluble PVA, cross-linking using glutaraldehyde GA, cross-linking using GA and HSA	Amperometry	Catechol	0–109	26 ± 1	Infusions of: *Salvia microphylla* *Lippia dulcis* *Lippia alba*
	Tyrosinase immobilization onto a carbon paste electrode, in a Nafion film	Amperometry	p-hydroquinone	20–120	1.6	Red wine
Laccase	Laccase immobilization onto AuNPs/GNPI/SPCE	Amperometry	Hydroquinone	4–130	1.5	Blueberry syrup Wine
	Laccase immobilization onto AuNPs/Ppy/SPCE	Amperometry	Polyphenolic compounds	1–250	0.83	Propolis
	Tyrosinase or laccase immobilization on the surface of GCE modified with GO-MWCNTs hybrid	Amperometry	Catechol, gallic acid, pyrogallol, 1,2-dihydroxybenzoic acid, dopamine, epicatechin, rutin, caffeic acid, chlorogenic acid	1–340	Tyrosinase 0.5 Laccase 0.30	Fruit juice

The antioxidant activity was assessed in respect to a 10 mol/L^{-1}trolox solution. The consequences that were found indicate that simple handling, a discriminating response and a quick assessment of the plant extracts antioxidant activity, among other. It established that a uncomplicated application of the presented biosensor provide knowledge about the overall antioxidant activity of various samples. This has number of reward, including simple treatment, targeted responses, quick assessments of plant extracts' antioxidant activity [22–24]. The

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electrochemical biosensors listed in Table 1 are designed to measure the quantities of antioxidants present in food. On enzymes, these biosensors are built.

AuNPs/GNPI/SPCE (grapheme nanoplates and gold nanoparticles modified the screen printed modifying carbon electrode); (Gold nanoparticles electrolytically deposited on screen printed carbon electrodes modified with polypyrrole) represent ITO, Indium Tin Oxide. Grapheme oxide and multi-walled carbon nanotubes and CA represent carbon atoms (chronoamperometry).

Table 2: Electrochemical Assays based on Sensors for theAntioxidants in Real Sample.

Nanomaterial (Sensor)	Antioxidants	Method	Linear Range (μM)	Limit of Detection (μM)	Real Sample
GCE	Gallic acid Rosmarinic acid Capsaicin Thymol Eugenol	CV	19.8–1000 49.5–495 52.9–1060 60–200 3.74–1870	0.57–12 1.8–40	Spices
Graphite modified with $[Cu_2tpmc](ClO_4)_4$ immobilized in PVC matrix	Gallic acid	DPV	2.5×10^{-1}–100	1.48×10^{-1} 4.6	Wine samples

USING A SUPEROXIDE DISMUTASE (SOD) BIOSENSOR

A study was conducted by experimental method assess the different types of wine antioxidant capability. To make the measurements, a comparison of the biosensor's come back to rising concentrations of the superoxides radicals generated in solution through the containing xanthine oxidase biosensor system was performed .and this comparison was carried out both with and without the test sample present. The findings were examined in light of those obtained using two conventional spectrophotometric methods as well as a spectrofluorimetric approach that was documented in the relevant body of scholarly work. A sulfite oxidase containing biosensor, tyrosinase biosensor and an ascorbate oxidase biosensor were used sequentially to determine the content of polyphenols, sulfites and ascorbic acid in the wine ssample analyzed diversely. Finally, we calculated ascorbic acid content by using an ascorbate oxidase biosensor [25].

ADVANTAGES AND DISADVANTAGES OF ELECTROCHEMICAL SENSORS

One of the most important applications of nanotechnology and materials science is the creation of novel sensors that may be utilized in the food industry or the pharmaceutical industry. In order to make the most efficient use of the available research resources, a great deal of focus has been placed on developing straightforward techniques that may produce results quickly and accurately yet requiring just a little amount of samples for testing. In this context, nanomaterials have been utilized in the development of an extensive array of sensors and detecting systems. Nanomaterials are put to use as catalytic process in order for increase performance detection, drawing attention to excellent sensitivity, selectivity and stability of non-materials. Electrochemical sensors have reward such as easy to handling, reproducibility, fast response, high compassion, low cost, long term constancy and precursors capability compared to traditional assays for detecting antioxidant activity. These benefits are in addition to the fact that electrochemical sensors can detect antioxidant activity. Despite the fact that nonmaterial-based on the electrochemical sensors has higher analytical sensitivity, they are able to react to a large variety of different chemicals. Therefore, in the majority of instances, they are in capable to distinguish among reactions of comparable electroactive containing functional groups contained in structures. This is particularly true for organic samples; this is highly complex due to the presence of inclusion of a extensive variety of inorganic and organic compounds [26].

MASS SPECTROMETRY METHOD

MS/MSmethodhasbeenconsistentforthescreeningoftotalandindividualphenolicconstituents producedbymajorIndian wine factories. Its levels correlated with the corresponding antioxidant activity. The wines were screened for total and individual phenolic constituents for screening purposes. Total polyphenol concentrations in wine vary depending on the grape variety used and the geographical area where the grapes are grown. The red wine had the highest total polyphenol concentration (1.07-2.62), followed by the "Rose" wine (0.24-0.49) and then the white wine (0.16-0.41). The free radical scavenging activities of red wines were found to vary between 0.21-0.72 mM trolox equivalent, which was much greater than those of "Rose" wines and white wines, which varied between 0.07-0.252 and 0.016-0.08 mM equivalent trolox. In addition, the ferric reducing antioxidant potency of the red wines was greater (mM quercetin equivalent, 2.01-7.04) than that of the "Rose" wines (0.46-1.82) and the white wines (0.07-0.71) respectively. The cluster analysis revealed a distinct separation of the wine samples into two main groups: those including red wines

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and those containing "rose" wines and red wines. It is the initial effort of its variety to study the entity phenolic content in the universal wines, and examine the relationship between this information and the wines' overall antioxidant capacity [27].

THE CYCLIC VOLTAMMETRY

The research conducted classifies to describe behaviour of catechin electrochemically on the glassy carbon electrodes. In spite of the adsorption processes, it was the realistic to analyse catechin at the concentrations ranged from 1 x 10^{-2} to 6 x 10^{-2}mol dm. These concentrations ranged covered in the range. Catechin scan be oxidized by the exchange of one or two electrons, enabled and electrochemical generation of iodine by outside adjustment with iodide ions. It is possible to perform potentiometric titrations of catechol with iodine using two electrodes polarized by low-intensity currents, but the results are essentially condition-dependent [28].

ELECTRONIC TONGUE METHOD

In the study conducted, electronic tongue technique was based on an injecting run arrangement and prepared with an amperometric multichannel detector were used to analyzed total phenolics level, bitterness levels in red wine and antioxidant activity. The detector consisted of our glassy carbon electrodes set in a square. The detector started with two comparable electrodes equilibrated atE1=+410 and E2=+810mV. The next two electrodes were set at E3=+810 and E4=410mV.This arrangement made it possible to collect data on the levels of antioxidant movement (E1), and total phenolic level (E2andE3) in the samples. TheE1/E2 ratio was used to represent the ratio of potent and non-potent antioxidants. A measure of reversibility can be expressed using E3/E4, and this was the case. In the end, the system was controlled using the ratio of E2 to E3, whereby in all, the four electrodes resulted in seven different variables, each of which contributed to the formation of a distinctive pattern profile. The antioxidant activity estimated by the technique Principal Component analysis (PCA). The bitterness value and total phenol contents value also estimated by this process. A total eleven variables were taken into consideration for this study. The findings of the antioxidant activity were shown to have a positive correlation with the Folin–Ciocalteu index table (R2 = 0.92). There was a significant correlation between bitterness and the e-tongue value (R2 = 0.80). In general, the proposed e- tongue method makes traditional sensory analysis much simpler (it only requires a dilution), faster (analysis takes place less than 25 seconds per sample), more cost-effective, more intent (precision value is within 6%, expressed as RSD %) [29].

POTENTIOMETRIC DETECTION METHOD

For the purpose of knowing the superiority of wines, a method that is both quick and precise for determining the gallic acid and antioxidant activity in wines. The purpose of determining the entire amount of phenolic compounds that are present in wine is that because it is a best way to understanding the superiority of wine. For that, a potentiometric method that is based on the removing of permanganate ions through the anion exchange membrane which fabricated on the indicator electrode .According to the findings, the presence of phenolic acid such as a natural antioxidant gallic acid causes an increase in potential for the potentiometric sensor. This was shown to be the case. In addition, the modified electrode sensor has increased potential response linearly throughout a concentration range of 0.04 to 2.9 g/L and has a detection limit of 6.5 mg/L, as determined by utilizing gallic acid as the standard. These sensors also have a short amount of time required for a response, a repeatability that is satisfactory, and stability over time. Based on these findings, it appears that the potentiometric sensor that was presented has the potential to be an effective and trustworthy instrument for the speedy detection of the gallic acid concentration and antioxidant activity in wine samples [30]. On the other hand an influential research hard work focused on their novel applications in the research field and, here ions are released from the membrane surface used for the measuring of total phenolic content and antioxidant properties in wine is the standing. Analysis conditions such as membrane composition, temperature, reproducibility of the electrode, pH, inner filling solution and adsorption time are optimized. The results obtained by this method and compared with the Folin–Ciocalteu method. And hopefully the renew method is very simple, low cost, time saving, and easily handling process.

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