International Research Journal of Natural and Applied Sciences
ISSN: (2349-4077)
Impact Factor 7.032 Volume 10, Issue 12, December 2023
Website- www.aarf.asia, **Email** : editor@aarf.asia , editoraarf@gmail.com

SYNTHESIS OF HETEROCYCLIC COMPOUND AS AN ANTIOXIDANT AND STUDY OF THEIR ACTIVITY

Gaurang Chudasama *[1], Riddhi Maru[1],Pravin Rajgadhi[1]
[1] Department of Chemistry, Narmada College of Science and Commerce,
Bharuch- 392001, Gujarat, India

ABSTRACT

Beginning with (2,3-dihydro-1H-perimidin-2-yl)-phenyl, the compounds that are the subject of the inquiry may be synthesised by introducing an OH group into the phenyl ring in either the ortho or para position. The nuclear magnetic resonance (NMR) and mass spectrometry (MS) analytical techniques have been utilised in order to provide a description of these three substances. The primary objective of our research is to determine the ability of the chemicals that we have developed to act as antioxidants. Compounds 1 and 2 exhibit powerful anti-free radical activities, even at low doses, according to the results of antioxidant activity screening that was carried out in line with the FRAP and DPPH procedures. Comparatively, compound 3, which has an OH group substituted at the para position, had the lowest level of activity. This is in contrast to compound 2, which demonstrated the highest level of activity under both circumstances. The para position appears to have the lowest chance of contributing to an increase in the antioxidant activity of this pharmacophore, according to the evidence that is currently available.

Keyword-:*heterocyclic ,compound , perimidine, , antioxidant , activity.*

INTRODUCTION

The presence of a certain (–N=N–) A group in the structure of an azo molecule is conjugated with two monocyclic or polycyclic aromatic systems that may be the same or different from one another. This group is what differentiates azo compounds from other types of compounds. There are many applications for azo compounds, including those in the fields of food additives, medicines, indicators, radical reaction initiators, dyes, and pigments. Azo compounds have a wide variety of applications. The initial stages of the azo color production process involve the diazotization of a primary aromatic amine and the subsequent coupling of that amine with one or more nucleophiles. Furthermore, research has shown that azo compounds possess antibacterial properties, which makes the situation much more unpleasant.

© Association of Academic Researchers and Faculties (AARF)
A Monthly Double-Blind Peer Reviewed Refereed Open Access International e-Journal - Included in the International Serial Directories.

Chalcones are a member of the flavonoids family of substances, which is one of the chemical groups that is utilised in medicine the most frequently. It has been proven that these compounds possess a wide range of biological effects, including antioxidant, antitumor, anticancer, and antimalarial activities.

Important heterocyclic compounds are pyrazoles. Their structure is comprised of two nitrogen atoms that are located in close proximity to one another and a ring that has five members. For instance, it has been demonstrated that pyrazole compounds possess beneficial biological or pharmacological effects, such as antifungal, antibacterial, anticancer, and anti-inflammatory activities. This is only one example of this phenomenon.

A wide variety of biological activities, including antioxidant, antibacterial, antifungal, analgesic, anticancer, and anti-inflammatory effects, have been seen in derivatives of isoxazole. These derivatives have also been shown to display pain relief qualities. It is known that these chemicals have a wide variety of interactions with living organisms. Many people are aware of the fact that certain chemicals have medicinal properties.

Oxazines are a kind of heterocyclic molecule that has just oxygen and nitrogen in its structure. They belong to a remarkable commodities family that includes synthetic and natural both compounds, and in addition to exhibiting positive biological qualities such as analgesic, antibacterial, anticancer, and anticonvulsant properties, they also contain these characteristics.

In addition to its use in polymers, medicines, agrochemicals, antioxidants, and dyes, pyridinines are also utilized in a broad variety of other applications. Pyridines are classified and belong to a separate category of chemicals. In addition to possessing a many pharmacological effects, including antihypertensive and anti-cancer capabilities, pyridine derivatives, notably cyan pyridines, are major herbicides and insecticides. They also have a many functions. One of the reasons for this is the high amount of bioactivity that they possess.

Thiazine is a heterocyclic molecule that is made up of four carbon atoms, one nitrogen atom, and one sculpture atom that are all dispersed around the six-member ring. Thiazine derivatives are not only absolutely necessary for the production of pharmaceuticals and the execution of a many varieties of biological processes, but they also have the potential to be utilized in the treatment of gastrointestinal problems and prevention of diabetes.

As a result of their antibacterial, anticancer, anticonvulsant, and analgesic qualities, several pyrimidine derivatives are utilized during treatment of thyroid diseases and leukemia. In addition to this, pyrimidine derivatives have been of great significance in the realms of medical chemistry, agricultural chemicals, and medicine.

LITERATURE REVIEW

Tsolaki et al. (2014). Reactive oxygen species, oxidative stress, and oxidative damage are being identified as key contributors to the development of disease states and the ageing process by an increasing number of researchers thanks to their extensive study. This is something that the general public is starting to acknowledge. When there is a low molecular oxygen level, reactive oxygen species, also known as ROS, are a sort of molecules that are produced during aerobic metabolism. These specific molecules are capable of displaying reactivity in chemical reactions. The production of reactive oxygen species (ROS) is possible

through the action of a large range of enzymes, each of which possesses unique characteristics. It is the responsibility of physiological antioxidants to exercise a stringent control on the quantities of reactive oxygen species (ROS) that are present under normal conditions. DNA, lipids, proteins, and carbohydrates are all susceptible to damage from oxidative stress, which occurs when there is an excessive synthesis of reactive oxygen species (ROS) or a decrease in antioxidant storage throughout the body. This imbalance between reduction and oxidation, which is often referred to as oxidative stress, may then play a role in the beginning stages of tissue damage and its progression, as well as in the pathophysiology of a number of different diseases. The dictionary definition for the term "antioxidant" indicates that it refers to "any substance that significantly delays, prevents, or removes oxidative damage to this target molecule when present at low concentrations compared with those of a substrate." However, only a small number of antioxidants are proven to be effective in vivo therapy, despite the fact that oxidative damage has been associated to a variety of clinically significant disorders. The difficulty of determining the antioxidant activity of a substance in living organisms are contributing factors for increasing complexity of providing an interpretation of the findings from clinical trials. Several synthetic chemicals have been shown to possess antioxidant properties, as this has been proved by a multitude of studies conducted by researchers. Despite the fact that some of them are manufactured from antioxidants that are present naturally in the environment, others have structures that are distinct from those of other antioxidants. This article discusses the methods that are utilised in order to evaluate the antioxidant properties of heterocyclic antioxidant compounds. Several of the classes that are reported the most frequently are included in the types of procedures that are utilised.

Jarallah et al. (2019). Purpose fordetermining whether or not they have antibacterial capabilities, a variety of recently discovered 2-methylquinazolin-4(3H)-ones, which included biphenyl derivatives (A1–A12), were manufactured with increased yields. Purpose for determining the structures of the compounds, FTIR and ^{1}H-NMR spectra data, in conjunction with the physical features of the compounds that were synthesized themselves, were employed. A method known as agar by diffusion was utilized in order to evaluate the antibacterial activity of these respective substances. Some of these compounds were shown to possess powerful antibacterial capabilities, particularly when compared to conventional antibiotics, as demonstrated by the experimental findings.

Mahaboob Basha et al. (2014). The creation of a variety of bis heterocycles, oxazolyl/thiazolyl/imidazolyl oxadiazoles with a styryl sulfonylmethyl group at the 5-position of the oxadiazole, and tris heterocycles with a pyrrolyl/pyrazolyl sulfonylmethyl group at the 5-position of the oxadiazole was accomplished through the utilisation of conventional and versatile synthetic techniques. The capacity of each and every molecule to perform the job of an antioxidant was investigated by the researchers. Compound 5b had a higher level of radical scavenging activity than compounds 8b and 14b, which demonstrated activities that were equivalent to those of ordinary ascorbic acid. This was the case across all three studies.

Shalaby et al. (2023). In this study, the activity of 1-(2-hydroxyphenyl)-3-(4-methylphenyl)prop-2-en-1-one (3) towards a variety of active methylene derivatives was investigated through the use of pressurised microwave irradiation, which is an energy source

that is safe for the environment. In order to produce the corresponding 2-hydroxyphenylcyanopyridone, 2-hydroxyphenyl acetylcyclohexanone, and thieno[2,3-c]chromen-4-one derivatives, Chalcone 3 was subjected to a reaction with ethyl cyanoacetate, acetylacetone, and thioglycolic acid at a temperature of 70 degrees Celsius, under pressure, and under microwave reaction conditions. Additionally, chalcone 3 and hydrogen peroxide can be utilised to produce a derivative of chromen-4-one that is identical to the original structure. In the course of this process, the two separate compounds are brought together. In order to validate the chemicals that were synthesised, spectroscopic methods such as mass spectrometry, 1HNMR, 13CNMR, and Fourier transform infrared spectroscopy were utilised. In addition, the heterocycles that were synthesised exhibited a significant level of antioxidant activity that was comparable to that of vitamin C. Since the OH group was present, scavengers were able to block radicals more efficiently than they would have been otherwise. In addition, the biological activity of compound 12 was demonstrated by the use of molecular docking stimulation, which included the utilisation of the proteins PDBID: 1DH2 and PDBID: 3RP8. Compound 12 was shown to be superior to ascorbic acid by demonstrating that it had a shorter bond length and a greater binding energy. This demonstrated that compound 12 was superior. The validation of compound 12 was accomplished by the use of a Hirsh field investigation to determine the interaction between the hydrogen electrostatic bond. In addition, X-ray single structure analysis was utilised in order to validate the chemicals analysed. In addition, when the compounds were compared to the ideal structure, a significant connection was discovered between the bond length, bond angle, FT-IR, and NMR of the compounds. In addition, the compounds were optimised by employing the DFT/B3LYP/6-31G (d,p) basis set and determining their physical descriptors. This was done in order to achieve the best possible results.

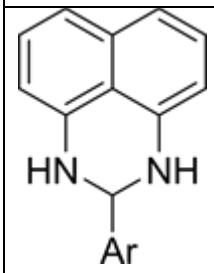
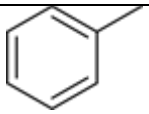
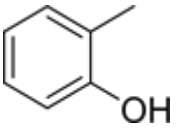
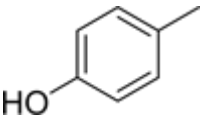
Abdel-Wahab et al. (2011). Purpose for determining the chemical performance of 5-bromo-2-(bromoacetyl)-thiophene (1), a number of bi-nucleophilic reagents were used. O-phenylenediamine, 2-aminopyridines, 2-aminobenzimidazole, 2-aminothiazoles, 2-aminotetrazole, 2-aminotriazole, and 2-aminopyridines were some of the reagents that were included in this group. A total of bridging nitrogen heterocycles were produced, with the thiophene moiety being placed at positions 3, 5, 7, 9, 11, 13, and 15. This procedure was carried out. Furthermore, the thiocarbamoyl and 5-bromo-2-(bromoacetyl)-thiophene compounds 17, 19, and/or 24 were responsible for the generation of the corresponding dithien-2-yl ketones 20 and 25, as well as the thienyl-thiazoles 18. The circumstances that remained throughout the period of the response were the ones that insisted on this. During the processing of chemical 1, 2-mercapto-4,6-dimethylnicotinonitrile was used in order to obtain the dithien-2-yl ketone 28 that was required. ABTS testing was performed on the recently produced scaffolds determine the amount of antioxidant activity that they possessed. This was done to determine the efficacy of the scaffolds. Additionally, it was observed that the 2-((2-[thiophen-2-yl]-2-oxoethyl)thio)nicotinonitrile derivative 27 and the thienyl-thiazole scaffold 18c both displayed a degree of radical scavenging activity that was regarded sufficient.

RESEARCH METHODOLOGY

Material

An extensive variety of compounds, including benzaldehyde, salicylaldehyde, 4-hydroxybenzaldehyde, and benzene-1,8-diaminonaphtalène, were among the substances that were supplied by Aldrich Corporation. Before they were put to use, they were not subjected to any additional purification processes. The drying processes were performed on each and every one of the organic solvents that were obtained from Merck before they were put to use. The information that was utilised in these melting point measurements was gathered with the assistance of an electrothermal melting point device that was manufactured by MPD MitamuraRiken Kogyo (Japan). In order to take the measurements, capillary tubes were utilised. A Bruker-Avance-300 spectrometer that operates at a frequency of 300 MHz was utilised in order to record the 1H nuclear magnetic resonance (NMR) spectra. For the purpose of obtaining the mass spectra, a TOF LCT Premier (WATERS) Spectrometer that was linked to an HPLC Alliance 2695 chain was utilised.

Table 1: The structures of 2,3-dihydro-1H-perimidinesynthesized compounds.

	compound	Ar
	1 2 3	  

Methods

2. Phenyl-2,3-Dihydro-1H-Perimidine Synthesis

In order to dissolve the chemicals 1,8-diaminonaphtalène (9.79 mmol) and benzaldehyde (19.60 mmol), fifty millilitres of ethanol were considered to be the appropriate amount. A green precipitate was produced as a result of the technique, which involved heating the mixture at reflux for a period of seven hours. Following the filtering and washing procedures that were carried out in ethanol, a precipitate was produced that had a concentration of 82% and a melting point of 206 degrees Celsius (Rf: 0.87 in hexane/acetate d'ethyle (2;1).

2-(2,3-Dihydro-1H-Perimidin-2-yl) Phenol Synthesis

For the purpose of dissolving salicylaldehyde (18.80 mmol) and 1,8-diaminonaphtalène (9.35 mmol), thirty millilitres of ether were utilised. Following three days of stirring the mixture at room temperature, a brown precipitate was seen to have formed. Because of this, the mixture became more stable than it had been before. Following the process of filtering and washing in ether, the precipitate that was produced (Rf: 0.70 in hexane/acetate d'ethyle (2;1)) had a yield of 26.97% and a melting point of 198.2 degrees Celsius.

4- Synthesis of 4-(2,3-Dihydro-1H-Perimidin-2-yl) Phenol

For the purpose of dissolving the substances 4-hydroxybenzaldehyde (12.61 mmol) and 1,8-diaminonaphtalène (6.32 mmol), approximately fifty millilitres of ethanol was utilised. A five-hour heating period at reflux was applied to the mixture in order to achieve the desired result of producing an amber precipitate. After being subjected to filtering and washing with ethanol (Rf: 0.61 in hexane/acetate d'ethyle (2;1)), the precipitate had a yield of 47.78 percent and a melting point that was more than 268 degrees Celsius.

The four gases are depicted in Figure 1, which also provides an illustration of a general synthesis.

Radical scavening Test

1. The test known as 2,2-diphenyl-1-picrylhydrazyl, or DPPH

2,2-diphenyl-1-picrylhydrazyl, also known as DPPH, was one of the first free radicals that was used to investigate the connection between the structures of phenolic compounds and their antioxidant properties.

Fundamental

Utilising UV-visible spectroscopy is a method that may be utilised to accomplish the task of monitoring the reduction of the free radical DPPH. A determination of the relative contribution of the antioxidants to the absorbance drop at 517 nm is what is required to accomplish this goal. The presence of free radical traps caused the transformation of DPPH, which had a purple hue, into 2,2-diphenyl-1-picrylhydrazine, which had a yellow tint for its colour.

Quantity

In order to carry out measurements of the DPPH radical trapping activity, the approach that was given was adhered to. The concentration of the pure chemical was determined by combining 100 microliters of each methanolic solution of the pure chemical (with concentrations ranging from 0.0625 to 1 mg/mL) with 2.5 millilitres of the methanolic solution of DPPH, which had a concentration of 0.025 grammes per litre. A pure chemical concentration was determined by doing this. In

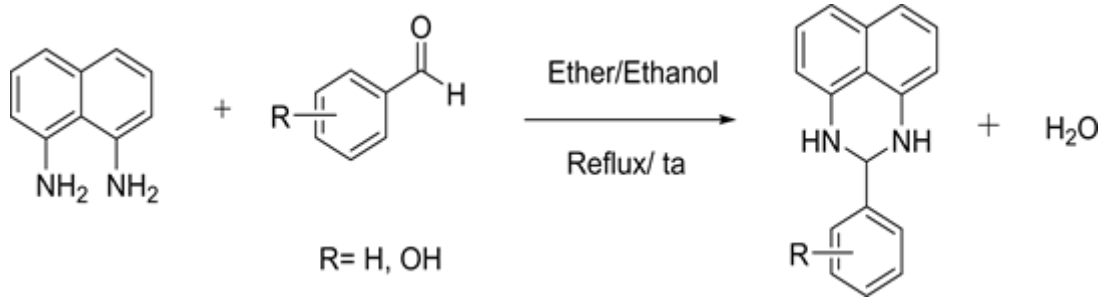


Figure 1: Compounds 1-3's general synthesis method.

During the course of the experiment, a negative control was created by combining 100 microliters of methanol with 2.5 millilitres of the methanolic DPPH solution.For each concentration, a blank was created and the absorbance was measured at 517 nm in compared to blank. This was done simultaneously. Following this, the blank was allowed to incubate for a period of thirty minutes at room temperature and without the presence of any light. Therefore, in order to serve as a positive control, the absorbance of a standard antioxidant solution, which was ascorbic acid, was measured at each concentration and under the identical conditions when compared to the samples.

If you would want an explanation of the results, which were reported as percentages of free radical inhibition (I%), the following formula was utilised to provide that explanation.

I% is equal to [(Abs sample-Abs of con neg)/Abs of con neg]× 100, for example.

The notation "I%" is used to represent the overall level of inhibition that is brought about by DPPH.

"Attenuation Sample" is a word that gives a description of the absorbance of the sample.

In the context of the process of taking in negative feedback, the term "abs of con neg" refers to the process.

FRAP, which stands for the Ferric Reducing Antioxidant Power test

Fundamental

The strategy consisted on reducing a triazine tripyridyl ferric complex to ferrous iron in the presence of antioxidants (the test sample). This was the basis of the technique. With the use of a colorimetric test that was carried out at a wavelength of 593 nm, it was demonstrated that the presence of antioxidants is the reason why the sample genuinely becomes blue. This will be the method that is used to produce the reagent.

Quantity

The methodology that served as the foundation for the procedure has been subjected to a number of modifications. Recently, a FRAP solution was prepared by combining 300 millimolar acetate buffer with 25 milliliters of water.

- 2.5 millilitres of an iron chloride solution containing 20 milligrammes. forty millilitres of hydrochloric acid and ten millimolar of TPTZ are combined to form the combination.

Throughout the entirety of the experiment, the mixture was located in an incubator and maintained at a temperature of 37 degrees Celsius. The experiment was donefor the purpose by combining three thousand microliters of working solution that had been maintained at a temperature of 37 degrees Celsius with one hundred microliters of extract that had been diluted with three hundred microliters of distilled water. The temperature of the water bath was fixed at 37 degrees Celsius, and a precise dark incubation time of thirty minutes was carried out in the water bath. There was a measurement taken at 593 nanometers to determine the absorbance after the treatment. In order to establish the calibration line, the absorbance measurement that was acquired for the trolox solution range (0.0312 to 1 mg/mL) was utilised. Purpose for establishing a benchmark for antioxidants, this spectrum was utilised. Purpose for determining the concentration of trolox equivalent in milligrammes per millilitre per gramme of dry matter, the regression line of the trolox sample curve was utilised.

DATA ANALYSIS

MS Research

There were peaks in the mass spectra of the compounds that matched to the molecular ions at m/z 263 [M + H]+. These peaks manifested themselves when the mass spectra were acquired using HR-ESI-MS. As a consequence of this, it would appear that the empirical formula for molecules 2 and 3 is C17H14N2, and this might be a possible solution to the problem. Both the empirical formula for the putative C17H14N2 compound and the peak of compound 1 at m/z 247 [M + H]+ were identical to one another throughout the whole experiment.

ThirteenC and One-H NMR Spectroscopy

The 1H and 13C nuclear magnetic resonance spectra of the compounds that were discovered in the laboratory by the use of a deuterated CDCl3 solution are presented in Table 2. The integration and multiplicity patterns of protons have been shown to be able to be utilised in the process of determining the resonances of individuals [24]. The 1H nuclear magnetic resonance (NMR) spectra of compounds 1, 2, and 3 displayed a great deal of signal, with corresponding values of 3.51 ppm, 3.50 ppm, and 3.36 ppm, respectively. In this way, signals like this were created by protons that were connected to the CH-N azote atoms. In compounds 1, 2, and 3, there is a singulet that has the potential to be connected to the cyclic protons CH- that are present in perimidines in some fashion. There is a possibility of detecting the singulet at concentrations of 5.80, 5.75, and 5.29 parts per million, respectively. It is believed that the aromatic protons associated with the three rings are responsible for formation of the multi-signals, which have intensities ranging from 8.19 to 6.47 parts per million.

It has been determined that a phenyl group is connected to the signals that are related with carbon at 60.97, 61.46, and 76.6 parts per million. These produced signals are linked with two extra azote atoms presence. Quantities of carbon are responsible for the occurrence of these signals.

By doing an analysis of the 1H-NMR spectra of the perimidines that were synthesised, it was possible to get results that were consistent with the structures that were hypothesised.

Anti-Radical Behavior with the DPPH Approach

The data that are displayed in Table 3 were created by the statistical analysis of the investigation. The results of the study shown in Table 3 demonstrated the antioxidant properties of each and every specimen that was examined. Furthermore, it was observed that there was a fluctuation that was statistically significant ($P < 0.001$) in the percentages of inhibition that occurred throughout the chemical transition. In the study, it was discovered that the percentage of inhibition for chemicals 2, 1, and 3 (Trolox) was 89,212 ± 0.462, 87,687 ± 1019, 73,574 ± 3025, and 43,598 ± 7743, respectively. These values were achieved by the use of the sequential sequence. According to the results of the DPPH trials, the antioxidant activity was placed in a decreasing sequence, just as it was with the FRAP approach. Trolox had the maximum antioxidant activity, followed by 2, 1, and then 3. In spite of the fact that the inhibition values for molecules 1 and 3 were significantly lower than those of Trolox, the inhibitory influence was still observable.

Table 1: The compounds' 1H and 13C nuclear magnetic resonance (NMR) data.

compounds	**Molecular formula**	**N-H** **m**	**C-H** **s**	**C6-H** **m**	**N-C-H**
1	$C_{17}H_{14}N_2$	3.53 (2H)	5.82 (1H)	8.08 - 6.49 (11H)	60.99
2	$C_{17}H_{14}N_2O$	3.52 (2H)	5.77 (1H)	8.24 - 6.50 (10H)	61.48
3	$C_{17}H_{14}N_2O$	3.38 (2H)	5.31 (1H)	8.19 - 66 (10H)	76.8

[a]When it comes to the statement of multiplicity, the letter m stands for multi-signals, whereas the letter c s represents singlet. Reporting chemical sludges is done with the use of PPMs. Integration is required to determine the number of protons that are included inside brackets.

Table 2:Percentage levels of inhibition using the DPPH technique.

Compound	**Means of inhibition % + standard deviation**
3	43.598 ± 7.743
2	73.574 ± 3.027
1	87.687 ± 1.022
TROLOX	89.212 ± 0.464
F	167.604
P	<0.003

The antiradical action of Compound 2 was demonstrated to be comparable to that of Trolox; this was demonstrated by statistical analysis. As can be observed in the histogram that is presented below (Figure 2), compound 3 was the agent that inhibited DPPH the least, even at dosages that were considered to be rather low.

Purpose for providing exhaustive information on the antioxidant capacity of this chemical series, the histogram graphical technique was utilised. Within the dose range of 1 to 0.0312 mg/ml, Compound 2 displays inhibitory percentage values that are comparable to those of Trolox One. In terms of antiradical activity, compound 2 performed better than the reference molecule when it was administered at a dosage of 0.5 minutes per millilitre. The substitution of a hydroxyde group for the 2,3-dihydro-1H-perimidine molecule at the para position on benzylic nuclei appears to have the potential to adversely effect the augmentation of biological activity. This is the case independent of the concentration of the hydroxyde group. This is the case regardless of the concentration that is being used. To the contrary, it would appear that the ortho position was the one that responded most favourably to the improved antioxidant properties of this pharmacophore. There is no other chemical class that, to the best of our knowledge, has ever demonstrated antioxidant properties of this considerable type.

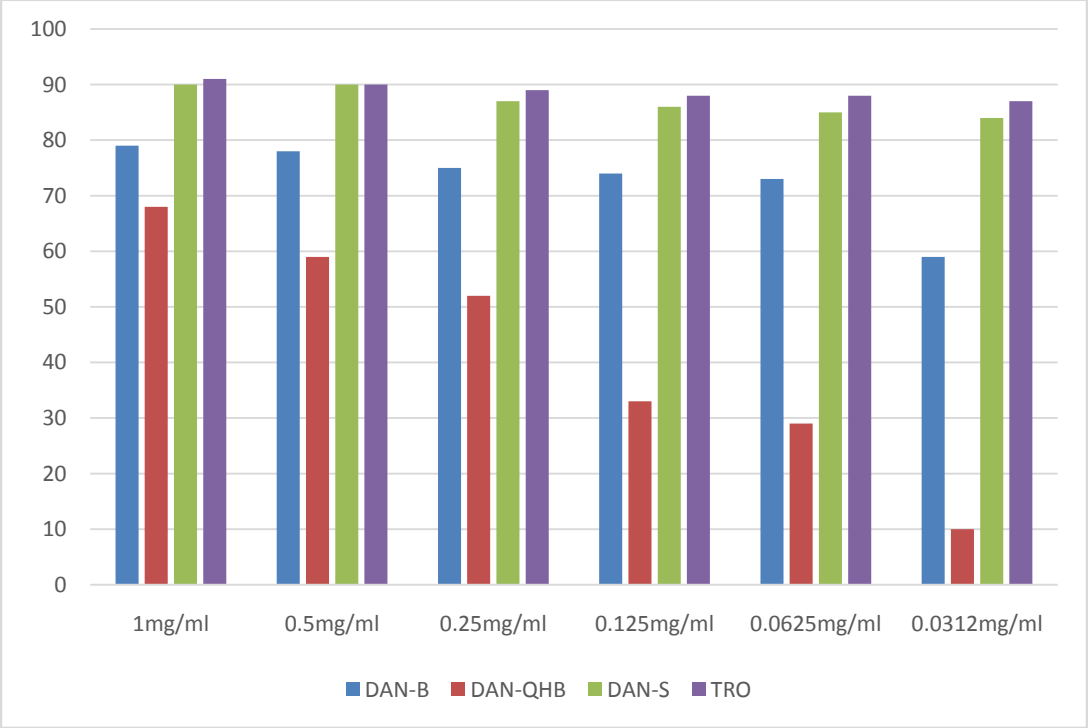


Figure 2:DPPH method antioxidant activity ranges from 1 to 0.0312 mg/mL..

FRAP Assay: Iron Diminishing Antioxidant Potency

Information on the power of ferric reduction as an antioxidant is shown in Table 4. The statistics shown here are reported in terms of mg/mL Trolox equivalent. These data were produced by employing a calibration straight line at a variety of dosages.

Table 3:The antioxidant capacity of pure substances reduced by ferric iron.

Compound	Means of inhibition % + standard deviation
3	0.07946658 ± 0.039254201
2	0.09285675 ± 0.04448094
1	0.09700133 ± 0.04513962
Fisher value F	20.621
P value	<0.003

Under the FRAP approach, the antioxidant activity in this series is rated one, two, and three in descending order, with one being the highest and two being the second highest.

Based on the findings, it is plausible to draw the conclusion that compound 1 and compound 2 exhibit a higher level of activity compared to compound 3 ($P < 0.001$). The values of the FRAP for compound 1 are 0.09700133 ± 0.04513959, whereas the values for compound 2 are 0.09285675 ± 0.04448092. It is possible to draw the conclusion from this that compound 1, which is the most active of the three, is the one that does not include any substitutions. FRAP value of Compound 3 is 0.07946658, with a standard deviation of 0.03925419. Compound 3 is the chemical that has the least amount of activity. Chemical 3, on the other hand, possesses not very high levels of antioxidant activity. The addition of a hydroxide group to the molecule resulted in a considerable decrease in the antioxidant activity of compound 1. since a consequence of this, Due to the fact that it did not induce any biological activity, the para position on the benzylidene nuclei looked to be the site on the nuclei that was the least sensitive.

CONCLUSION

Compounds 1 and 2 were shown to possess powerful antiradical capabilities by the utilisation of FRAP and DPPH-based antioxidant screening. According to the findings of the study, the antioxidant activities were also found to be arranged in a decreasing order, with 1 leading to 2 leading to 3 for FRAP antioxidant activities and 2 leading to 1 leading to 3 for DPPH antioxidant activities. In the FRAP scenario, the ortho-substituted compound 2 and the no-substituted molecule are the most active molecules, even in low concentrations, according to the DPPH example. This demonstrates that these compounds are the most effective. Chemicals 2 and 1 are aggressive rivals for the establishment of a new class of antioxidant compounds with a 2,3-dihydro-1H-perimidine profile. This is due to the fact that both of these chemicals possess outstanding antioxidant activity.

REFERENCES

[1] Tsolaki, E., Nobelos, P., Geronikaki, A., & Rekka, E. A. (2014). Selected heterocyclic compounds as antioxidants. Synthesis and biological evaluation. Current Topics in Medicinal Chemistry, 14(22), 2462-2477.

[2] Jarallah, S. A., Nief, O. A., & Atia, A. J. K. (2019). Synthesis, characterization of heterocyclic compounds and preliminary evaluation of their antibacterial activity and antioxidant agents. Journal of Pharmaceutical Sciences and Research, 11(3), 1010-1015.

[3] Mahaboob Basha, N., Seenaiah, D., Padmaja, A., Padmavathi, V., Bhargav, D. S., & Vijaya, T. (2014). Synthesis and antioxidant activity of Bis and Tris Heterocycles. Archiv der Pharmazie, 347(1), 54-67.

[4] Shalaby, M. A., Fahim, A. M., & Rizk, S. A. (2023). Microwave-assisted synthesis, antioxidant activity, docking simulation, and DFT analysis of different heterocyclic compounds. Scientific Reports, 13(1), 4999.

[5] Manojkumar, P., Ravi, T. K., & GOPALAKRISHNAN, G. (2009). Synthesis of coumarin heterocyclic derivatives with antioxidant activity and in vitro cytotoxic activity against tumour cells. Acta Pharmaceutica, 59(2), 159-168.

[6] Abdel-Wahab, B. F., Awad, G. E., &Badria, F. A. (2011). Synthesis, antimicrobial, antioxidant, anti-hemolytic and cytotoxic evaluation of new imidazole-based heterocycles. European journal of medicinal chemistry, 46(5), 1505-1511.

[7] Mallikarjuna Reddy, G., Ramachandra Reddy, P., Padmavathi, V., & Padmaja, A. (2013). Synthesis and Antioxidant Activity of a New Class of Mono- and Bis- Heterocycles. Archiv der Pharmazie, 346(2), 154-162.

[8] Santosh, R., Selvam, M. K., Kanekar, S. U., & Nagaraja, G. K. (2018). Synthesis, characterization, antibacterial and antioxidant studies of some heterocyclic compounds from triazole- linked chalcone derivatives. ChemistrySelect, 3(23), 6338-6343.

[9] Hossain, M. M., Shaha, S. K., & Aziz, F. (2009). Antioxidant potential study of some synthesized N-heterocycles. Bangladesh Medical Research Council Bulletin, 35(2), 49-52.

[10] Nyaki, H. Y., & Mahmoodi, N. O. (2021). Synthesis and characterization of derivatives including thiazolidine-2, 4-dione/1-H-imidazole and evaluation of antimicrobial, antioxidant, and cytotoxic properties of new synthetic heterocyclic compounds. Research on Chemical Intermediates, 47(10), 4129-4155.

[11] Abdelhamid, A. A., Salah, H. A., & Marzouk, A. A. (2020). Synthesis of imidazole derivatives: Ester and hydrazide compounds with antioxidant activity using ionic liquid as an efficient catalyst. Journal of Heterocyclic Chemistry, 57(2), 676-685.

[12] El-Mekabaty, A. (2015). Synthesis and antioxidant activity of some new heterocycles incorporating the pyrazolo-[3, 4-D] pyrimidin-4-one moiety. Chemistry of Heterocyclic Compounds, 50(12), 1698-1706.

[13] Fadda, A. A., El-Mekawy, R. E., Soliman, N. N., Allam, A. M., & Abdelaal, M. T. (2018). Synthesis, characterization, antioxidant and antitumor evaluation of new phthalocyanines containing peripherally functionalized fused heterocyclic compounds. Dyes and Pigments, 155, 300-312.

[14] AlNeyadi, S. S., Amer, N., Thomas, T. G., Ajeil, R. A., Breitener, P., & Munawar, N. (2020). Synthesis, characterization, and antioxidant activity of some 2-methoxyphenols derivatives. Heterocyclic Communications, 26(1), 112-122.

[15] Ismail, M. F., & El-sayed, A. A. (2019). Synthesis and in-vitro antioxidant and antitumor evaluation of novel pyrazole-based heterocycles. Journal of the Iranian Chemical Society, 16, 921-937.