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NAPHTHOQUINONES: A BRIEF REVIEW

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ABSTRACT: Quinones are a class of extremely reactive naturally occurring chemical entities including an extensive variety of biological functions, & their reactive nature as well as structural composition is an intriguing topic that is being investigated around the globe. The group of organic quinones which include naphthoquinone. There isan ongoing theme extending across the activities, and numerous research have been developed to better understand the details of these activities. The naphthoquinones & their analogues offer several pharmacological actions, involving an antioxidant, antibiotic, antiviral, cancer prevention. antimalarial, as well as antifungal capabilities. The objectives of this study aim provide recent information from the literature on the chemistry and methods for preparation of Naphthoquinone and their pharmacological activities. All the information has been collated, set up, and arranged in rational areas to offer a recent overview of the area of naphthoquinone chemistry. The present article reveals naphthoquinones' compositional variation and fascinating biological roles. This present article reveals the understanding of the synthetic approach for several derivative, their activity and medicinal uses.

INTRODUCTION: The biosynthetic origin and structural characteristics of secondary metabolites in plant species are the key categories for classification. Citing as pertinent examples flavonoids, alkaloids, terpenes, coumarins, phenolic acids, and quinones [1]. There are around 1200 naturally occurring chemicals that fall under the category of quinones, which have an ubiquitous quinoid structure [2]. The existence of substituted molecules either inside the quinonic or on the neighbouring rings greatly impacts how quinones function chemically.

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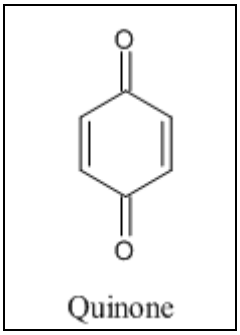
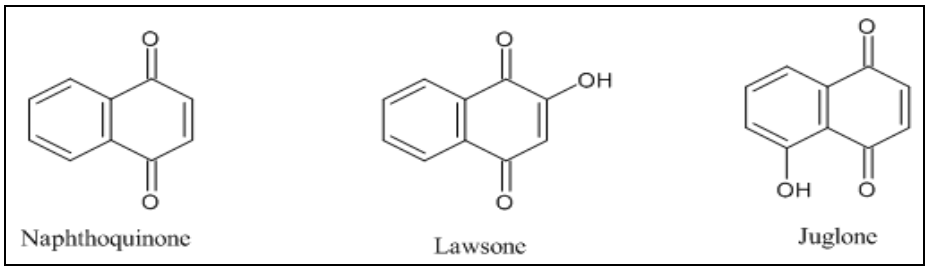
Different medicinal properties can be seen when quinone analogues containing hydroxyl groups are used. There are various quinones in nature that have a direct connection to a quinone structure by multiple hydroxyl groups. The quantity, structural diversity, and vast array of potent pharmacological benefits of quinone derivatives, such as vitamin K, plumbagin, juglone, lawsone, and shikonin, interested specialists across all over globe [3].



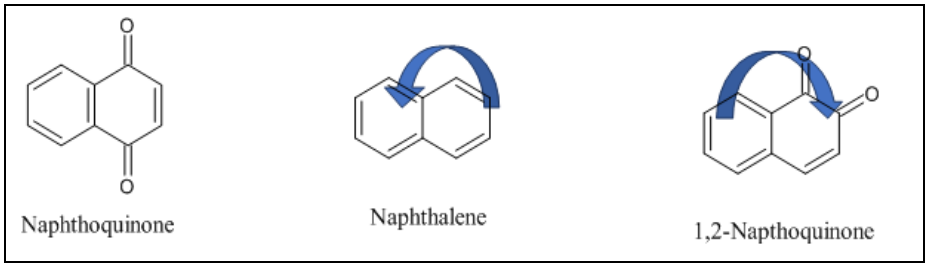
Quinone

To create 1,4-naphthoquinone [4], a chemical in which the 1,4-quinoid nucleus is annulated with an aromatic (benzene) ring, two benzene ring atoms in the -position of the naphthalene nucleus must be oxidised. The quinone ring has a system of double bonds conjugated to carbonyl groups, making it easily reacted with by O-, N-, and Snucleophiles. By using a variety of agents, 1,4-naphthoquinone can be quickly reduced and changed into 1,4-dihydroxynaphthalene. Lawson and juglone [5], two naturally occurring hydroxyl derivatives of 1,4-naphthoquinone with hydroxyl groups in the α- and β-αpositions of the naphthalene core, are employed as dyes [6].



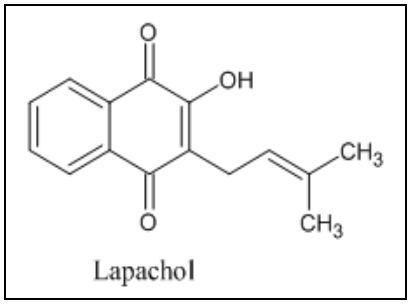
Structural Diversities of Naphthoquinone Entities: From a structural perspective, naphthoquinones are bicyclic compounds because they have two carbonyl groups in either position 1, 4 or 1, 2. Naphthoquinones' chemistry and biological function are significantly influenced by the location and chemical composition of the side groups that are attached to them. The naphthoquinone's ring structure is coated with a variety of groups, including hydrogen, hydroxyl, methyl, nitrogen, sulphur, and halide. A hydroxyl and/or methyl group are often present in a quinone's structure in nature. There have been numerous recognised pharmacological uses for these substances [7].

Chemistry of Naphthoquinone: Naphthoquinones are chemical compounds that are structurally linked to naphthalene. They are known as 1,4-naphthoquinones because they have two carbonyl groups in the 1,4 positions. There is a small chance that carbonyl groups will also be present at the 1,2 locations [8]. With hues ranging from yellow to red, naphthoquinones are highly reactive chemical molecules that are employed as natural or artificial dyes. These are α, β-unsaturated carbonyl compounds, together with their derivatives. 1,4-Naphthoquinone, which has a bright tint, is produced by the conjugation of double bonds with carbonyl groups [9].



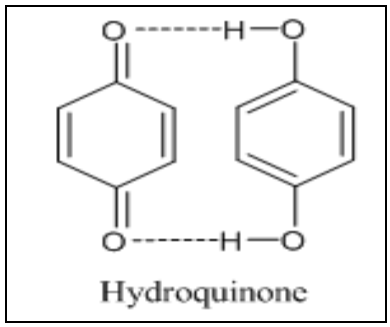
In several traditional Asian remedies, naphthoquinones coloured chemical compounds that are naturally occuring secondary metabolites of plants are employed [10-13]. Due to their large and diverse range of biological action, naphthoquinone nuclei have previously been thoroughly investigated by the field of medicinal chemistry.) Many natural and synthetic compounds of naphthoquinone have potent antibacterial, anti-inflammatory, neuroprotective, and cytotoxic properties [14–18].

A wide range of chemical compounds, such as benzoic acid and its derivatives, benzaldehydes, cyclopentene dialdehydes, flavonoids, which furan, a naphthoquinone, quinones, which naphthoquinones and anthraquinones, found abundant in the inside peel of tree and duramen of red lapacho [19]. Lapachol, known for its cancer-fighting properties, was the earliest naphthoquinone to be extracted using duramen of red lapacho. The formula of this compound represents $C_{15}H_{14}O_3$ [20].



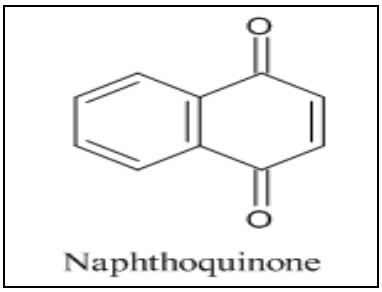
Lapachol

The photo chromic group known as quinones is well recognised for having two characteristic forms: a coloured quinone form and a colourless hydroquinone form. The two kinds can be combined through chemical or electrochemical stimulation. Seldom are photochromic quinones-based photo switchable fluorescence switches found. This redox mechanism is used in numerous biological electron transport systems. It is a reversible process in which two protons and two electrons are exchanged in a protic medium to convert quinone to hydroquinone. Hydroquinones are excellent electron donors and acceptors, while quinones have demonstrated to be good electron acceptors [21–24].

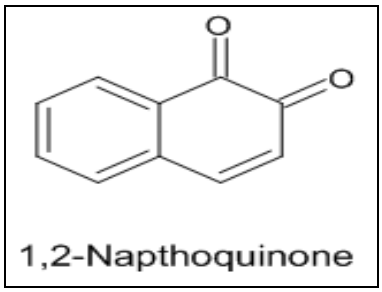


Hydroquinone

The molecular composition of the monomeric naphthoquinones C1 and C4 (1,4-naphthoquinones) or C1 and C2 (1,2-naphthoquinones) depends upon the Naphthalene framework with carbonyl groups placed at locations. Whenever combined, monomeric naphthoquinones can form dimers, trimers and less frequently, tetramers with a variety of possible an alternative class [25].

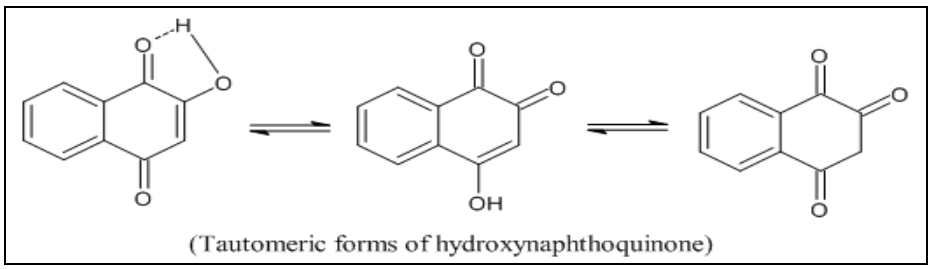


Naphthoquinone



1,2-Napthoquinone

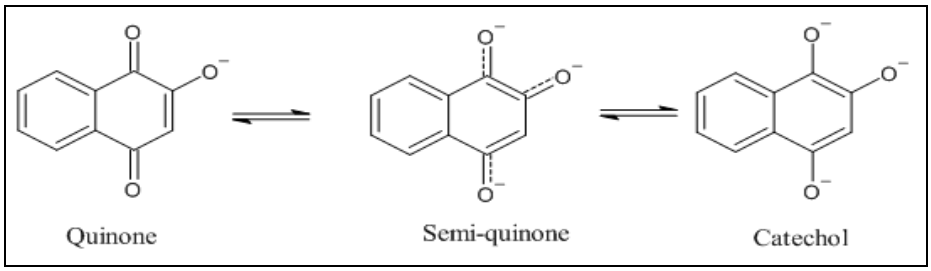
Structural Properties of Naphthoquinone: A typical C_9-C_{13} chain hydroxynaphthoquinone is a crystalline yellow solid with a melting point of between 70 and 130 degrees. Somewhat soluble in alcohol or lignin, more soluble in acetic acid, benzene, or ether and only very marginally soluble in water [26]. Lawson has the chemical formula $C_{10}H_6O_3$ and a melting point of 190°C. There are three tautomeric variants of it. The most stable tautomeric form is the 1,4-naphthoquinone structure, followed by the 1,2-naphthoquinone and 1,2,4-naphthotrione. The trione system is the least stable but is likely in equilibrium in solution with the other two tautomeric forms. The 1,4 isomer's stability results from the cancelling of carbonyl groups' dipolar moments in conjunction with intramolecular hydrogen bonds [27].



(Tautomeric forms of hydroxynaphthoquinone)

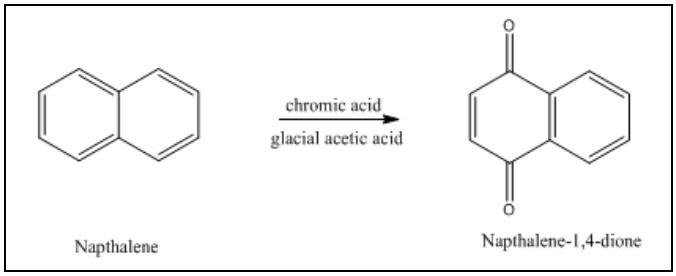
Quinones, semiquinones (the one-electron reduced form of quinone) [28] and catechol (the two-electron reduced form) are equivalent materials that tend to link to the ions of metals in three distinct modes of

oxidation, and it is suggested that these molecules have an essential function in biological processes partly because of their capacity to adhere [29]. The catalytic process for oxidation is initiated by the metal focused which may sustain the coordinated semiquinone (II) and catechol (III) forms of the naphthoquinone [30].



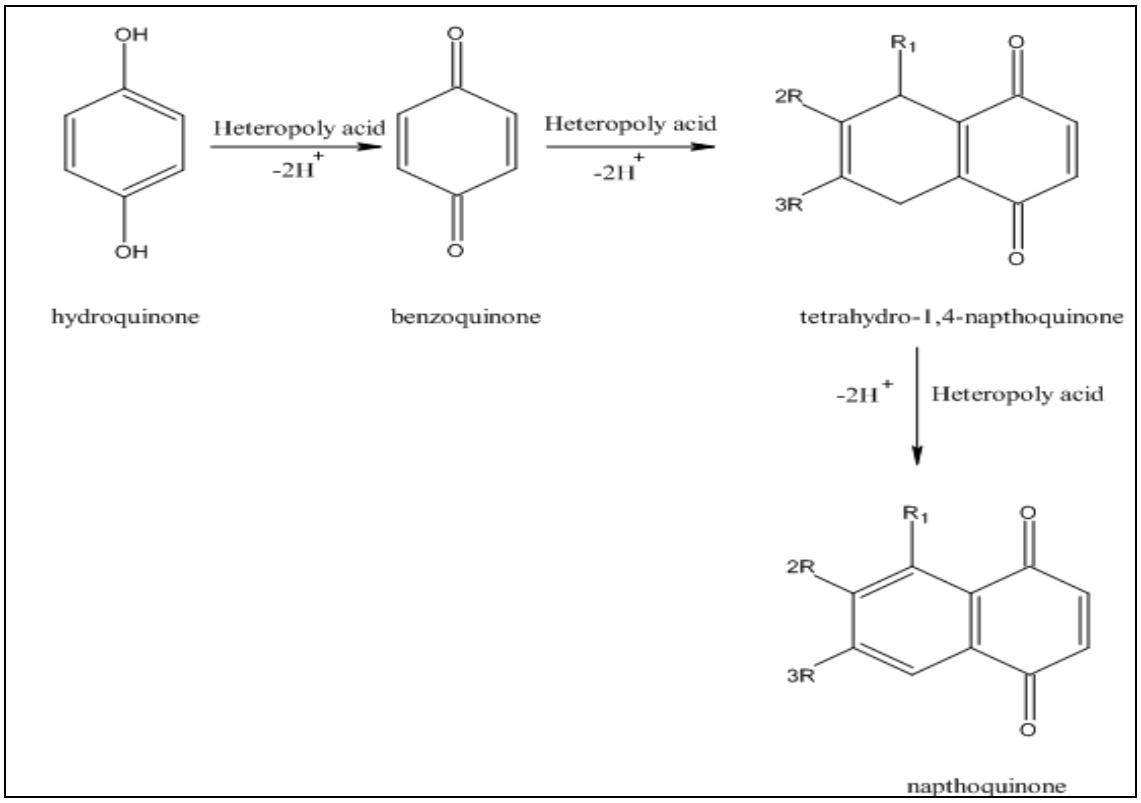
Synthetic Approaches of Naphthoquinone: There are many methods to synthesize naphthoquinone and its derivatives. In which they are listed below.

Synthesis from Naphthalene: For the synthesis of 1,4-napthoquinone firstly the naphthalene was mixed with the chromic acid and the glacial acetic acid [31-32].

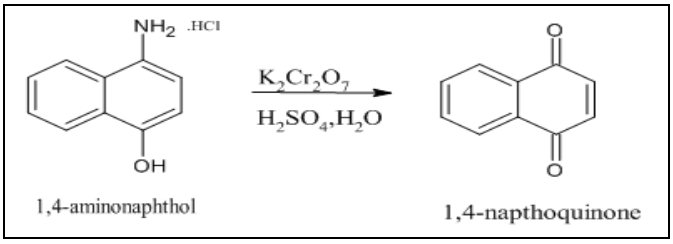


Synthesis from Hydroquinone: To synthesizenaphthoquinone from hydroquinone by using organic solvent 1,4-dioxane and Heteropoly acid (HPA). Then it is washed with water and it is dried over by using v_2o_5.

The formed product is benzoquinone then this reacts with the isoprene &the formation of substituted tetrahydro-1,4-naphthoquinone (THNQ). Treatment of THNQ with heteropoly acid solution the formation ofsubstituted dihydro-1,4-naphthoquinone (DHNQ) and again treated with heteropoly acid the reduction reaction gets occurred and formation of desired substituted 1,4-naphthoquinonethe way displayed in the parts that follow schematic [33].

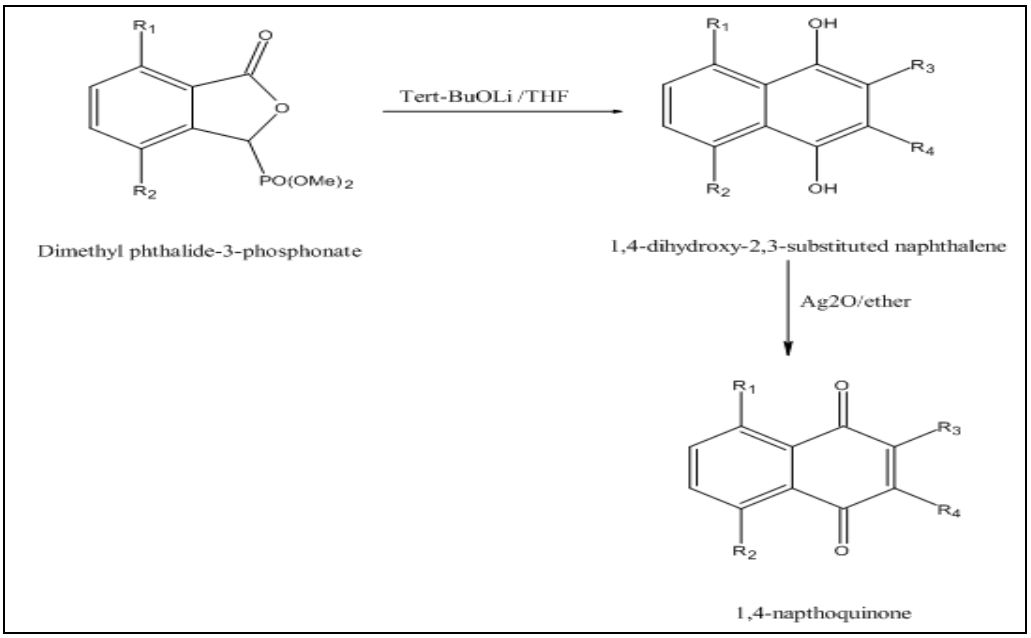


Synthesis from 1, 4-aminonaphthol hydro-chloride: 1,4-napthoquinone can be prepared by oxidation of 1,4-aminonaphthol with the help of potassium dichromate or ferric chloride and concentrated sulphuric acid [31].

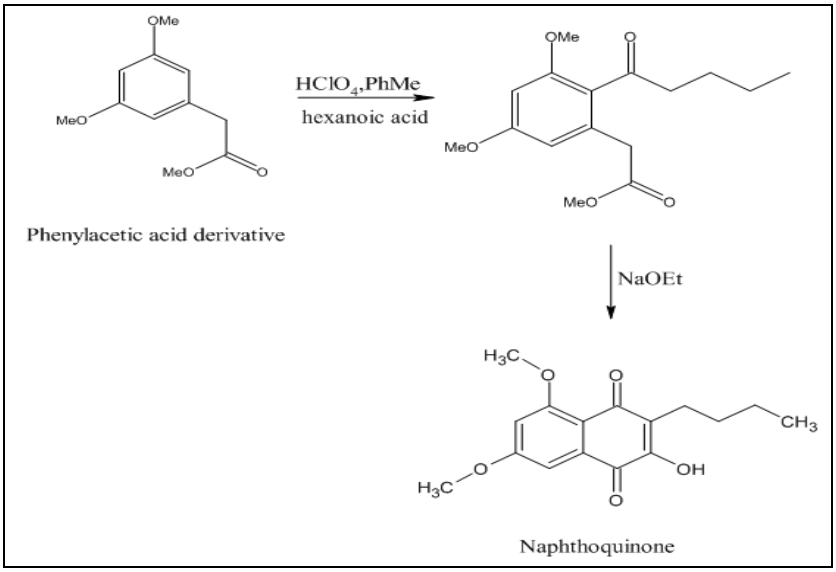


Synthesis from dimethyl phthalide-3-phosphonate: Dimethyl phthalide-3-phosphonate was mixed with tetrahydrofuran solution and with tert-BuOLi at -78°C for 30 minutes after work-up will gave 1,4-dihydroxy-2,3-substituted naphthalene by annulation process.

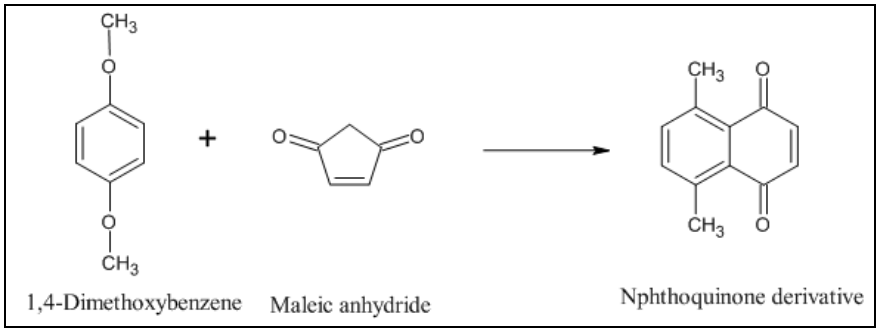
Some of substituted naphthalene-1,4-diol can be easily reacted with the oxidizing agent Ag_2O in the presence of ether which will form 1,4-napthoquinone [34].



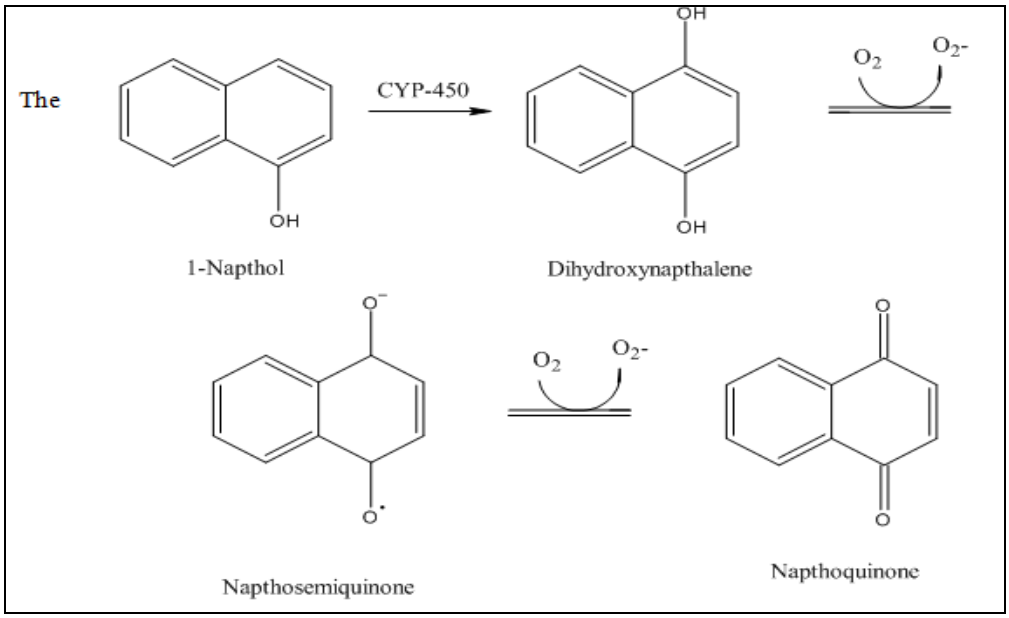
Synthesis from Phenylacetic Acid Derivative: The ketone with a good yield is obtained by acylating the phenylacetic acid derivative with the corresponding amounts of hexanoic anhydride in toluene that contains catalytic perchloric acid. by cyclization process ketone gets converted into 1,3,6,8- tetraoxygenated-2-alkyl-naphthalene with the major product as a naphthoquinone [35].



Synthesis from 1,4-dimethoxybenzene: Synthesis of naphthoquinone from the reaction in between 1,4-dimethoxybenzene and maleic anhydride by using $AlCl_3$ and NaCl were put together to generate naphthazarin, a precursor of a naphthoquinone [36-37].



Synthesis from 1-napthol: The generation of a polyol by 1-naphthol's hydrogenation *via* OH' and/or Cytochrome P-450 occurs within oxidation process of a polyol to 1,4-napthoquinone [38].



Therapeutic Activities of Naphthoquinone: Since, they have biological attributes, industrial uses, and their capacity to function an intermediary in the biosynthesis of heterocyclic compounds, naphthoquinones are one synthetic group that has maintained of constant fascination over the past few decades [39-40].

This is worthwhile to point out both cellular biological as well as pharmacological features have also been recorded for such molecules in either a diversity of research, involving tissue regeneration, anti - fungal, anti-inflammatory, anti - oxidative, leishmanicidal, as well as antineoplastic activity [41–46]. The several treatments, notably streptonigrin1, actinomycins 2, mitomycins 3, as well as others, are documented to be containing the 1,4-naphtoquinone subunit, which provides antitumor potential [47-49].

Naphthoquinone-containing composites exhibit favourable efficacy towards human cervical carcinoma, breast cancer, liver cancer, and Gastric cancer [48-51].

Numerous organic and chemical substances do have 1,4-naphthoquinone framework, as well as the dual attached carbonyl compounds at C_1& C_4 is what really give this complex their biological function [52]. According to research detailing to creation, manipulation, or investigation of a biological functions of organic products with a 1,4-naphthoquinone nucleus [53].

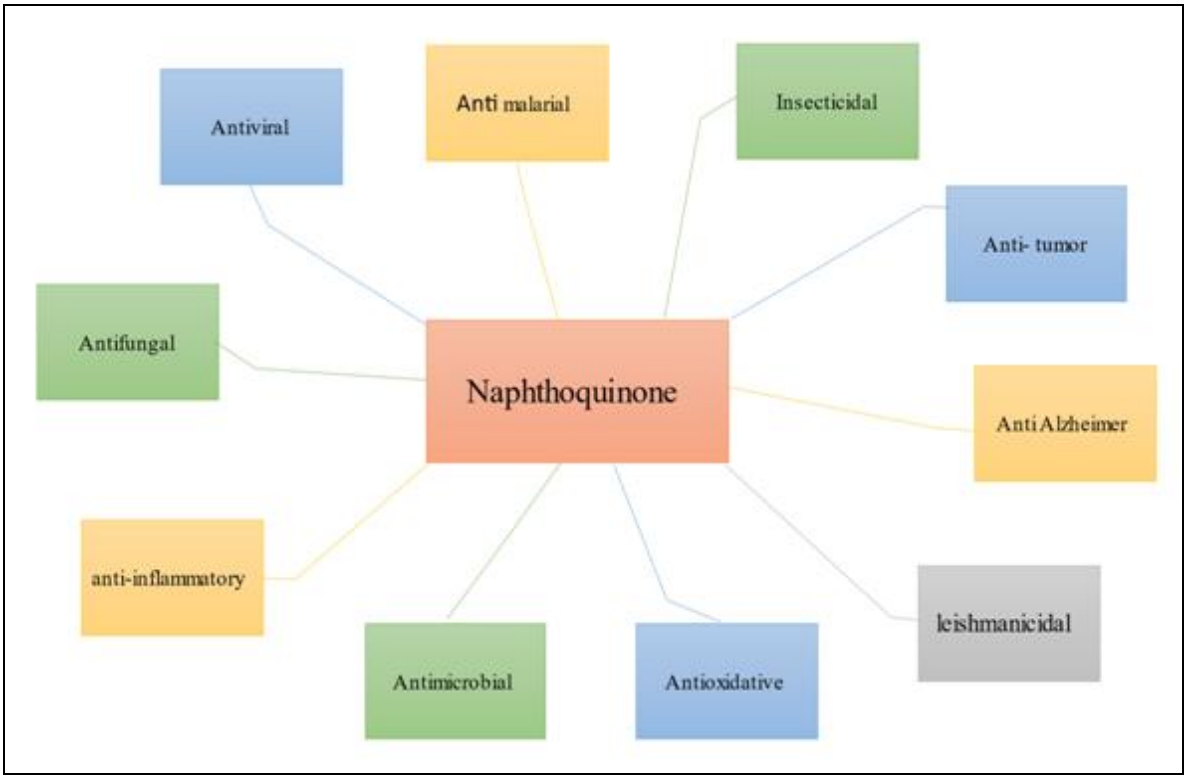


FIG. 1: NAPHTHOQUINONE SHOWING DIFFERENT KINDS OF ACTIVITIES

SUMMARY: A wide range of a novel 1,4-naphthoquinones have been created identified via natural sources all throughout the previous ten years.the many kinds of biological functions performed by naphthoquinones indicate that they are an appealing class of synthetic substances. 1,4-naphthoquinones represent a category of chemical compounds that possesses an enormous variety of biological roles and have considerable possibilities for usage in medication. The scientific study of naphthoquinone is expected to be promising in the coming decades.

The enormous quantity of literature that has been constantly expanding over time will make sure that the chemistry of naphthoquinone maintains an appropriate study in the decades afterward. However, the combinatorial properties of Naphthoquinones & their analogues positioned them to be an emerging substance in the field of therapeutic chemistry.

ACKNOWLEDGEMENT: Nil

CONFLICT OF INTEREST: Nil

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