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Anthraquinone derivatives pdf

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Anthraquinones are a class of natural and synthetic compounds with diverse applications and have been utilized for centuries for medical purposes. These compounds exhibit various pharmacological actions such as antioxidant, anti-inflammatory, and anticancer properties, making them valuable tool compounds for biochemical and pharmacological studies. The quinone moiety in anthraquinones raises safety concerns, leading to critical reassessment of their use as laxatives. This review article provides an overview of the chemistry, biology, and toxicology of anthraquinones, focusing on their potential as drugs and therapeutic agents. Given article text here ROS can cause various diseases including neurodegenerative disorders, cancer, liver diseases and cardiovascular disease etc. The mechanism of these diseases are ROS mediated. For example in Alzheimer's disease ,the long lasting generation of ROS by amyloid beta peptides causes damage to the brain. Elevated levels of ROS can also damage DNA, transform normal cells into cancerous ones and promote tumor growth. Excessive amount of ROS leads to fibrosis, liver inflammation and hepatocellular carcinoma. Endothelial cells and vascular smooth muscle cells are targets for ROS. High levels of ROS can damage vascular cells, cause proliferation and migration of vascular smooth muscle cells leading to vascular remodeling. Therapeutic strategy involves maintaining the balance of ROS by targeting ROS producing system. Antioxidants such as enzymes like superoxide dismutase and catalase and nonenzymatic antioxidants like polyphenols are studied for their ability to reduce oxidative damage. Natural anthraquinones with antioxidant properties have been found in various plants, they can directly degrade ROS and interact with signaling pathways to reduce oxidative stress. The anthraquinone compounds, renowned for their antioxidant properties, have been extensively reviewed. The primary focus of this work is depicted in Figure 2. Free radicals are ubiquitous in all molecules with unpaired electrons [25]. As aerobic organisms, humans inevitably generate free radicals [26]. Mitochondrial enzymes, NADPH oxidase, nitric oxide synthase, and xanthine oxidase are significant endogenous sources [27-30]. External factors like environmental pollutants, radiation, smoking, and drugs can also contribute to ROS formation [31]. ROS products include hydroxyl radicals, superoxide anions, nitric oxide, and peroxy radicals in radical forms [32], as well as hydrogen peroxide, singlet oxygen, hypochlorous acid, and peroxynitrite in nonradical forms [33-34]. ROS have both beneficial and detrimental effects on biological systems [31]. The delicate balance between these two effects is achieved through redox regulation [35]. Oxidative stress arises from the imbalance between antioxidant defenses and intracellular accumulation of ROS [36], which can contribute to life-threatening diseases like Alzheimer's disease, liver injury, and cancer. Consequently, counteracting harmful effects generated by ROS is crucial, achievable through antioxidant use [37]. Metals play a vital role in ROS formation and elimination [38-39]. Metal ions with redox activity, such as iron and copper, are cofactors for various enzymes but can also produce ROS and cause harm [40]. For instance, Fe^{2+} catalyzes the Haber-Weiss reaction to generate more harmful hydroxyl radicals from superoxide anions [41]. Cu^{2+} directly causes ROS production and reduces glutathione levels at high concentrations [43]. Zinc is an essential nutrient for maintaining life forms. Zn^{2+} primarily protects proteins and enzymes from oxidation or inhibits the formation of hydroxyl radicals by hydrogen peroxide through the Fenton reaction [44]. Hydroxyl radicals are the most destructive species in free radical pathology, inducing oxidative damage in almost all cell molecules [45]. A detailed illustration of ROS formation is shown in Figure S1. Living cells contain both low molecular weight antioxidants and Molecular weight antioxidants and enzymes shield cells from damage caused by rogue free radicals, both preventing and repairing harm. These powerful agents can be broadly categorized into two types: preventive antioxidants that neutralize free radicals at the initiation stage, and chain-breaking antioxidants that capture and prevent further propagation of free radical chains. Studies have shown that phenolic compounds possess three primary antioxidant mechanisms: hydrogen atom transfer, single-electron transfer followed by proton transfer, and sequential proton loss and electron transfer. The effectiveness of these mechanisms can be influenced by factors such as bond dissociation enthalpy, ionization potential, and proton affinity potential. Furthermore, the choice of solvent can also impact the preferred reaction pathway, with hydrogen atom transfer often favored in non-aqueous solvents and sequential proton loss and electron transfer in aqueous solutions. A density functional theory approach has been applied to accurately predict the antioxidant activity of various polyphenol extracts and elucidate their structure-activity relationships. By utilizing the density functional theory calculation with the B3LYP hybrid functional and the 6-311++G** basis set, the study revealed that compound 2 demonstrated the lowest HOMO-LUMO energy gap value (Table S1 in Supplementary Materials), indicating its increased propensity to donate electrons and exhibit superior antioxidant activity compared to compounds 2a, 2b, and others. This was attributed to the presence of more electron-donating phenoxy groups in compound 2. Theoretical studies by Jeremic et al. [59] and Markovic et al. [62] employed various methods to investigate the antioxidant capacities of different anthraquinone compounds. The results showed that compounds with hydroxy groups on the ortho position exhibited higher reactivity, while those with three or two hydroxy groups displayed moderate and low antioxidant capacities, respectively. Isin [60] utilized a conductor-like polarizable continuum model to study the free radical scavenging activities of four hydroxyanthraquinones. The order of hydrogen supply capacity was found to be compounds 11 > 12 > 14 > 13, with BDE values indicating that compounds with ortho-hydroxy groups had lower values compared to those with carboxyl groups. Theoretical studies also identified the most active sites for different compounds: 1-OH and 8-OH for compounds 2 and 5, and 3-OH for compounds 1 and 6 [61]. Markovic et al. [62] analyzed the BDE values of all hydroxyl positions in compound 1 to clarify the role of 3-OH in antioxidant properties. The study also evaluated the antioxidant activity of compound 10 theoretically by its BDE and IP values (Table S3 in Supplementary Materials). The results indicated that the free radical scavenging characteristics were well explained by HAT, with a lower IP value for aqueous solution suggesting the SET-PT mechanism was reasonable. In summary, anthraquinone compounds can scavenge various radicals, including •OH, DPPH•, and $O_2^{\bullet-}$, and inhibit lipid peroxide to exert their antioxidant effects. Phenolic Compounds Exhibiting Antioxidant Properties Plant phenols, particularly compounds 1, 2, and 3, have been found to play a protective role in protecting against DNA and mesenchymal stem cell damage induced by •OH. These compounds exhibit antioxidant effects through HAT (hydroxylation at the α-position) and SET-PT (ethylation at the γ-position) mechanisms, which involve the partial oxidation of phenolic hydroxyl groups into stable semiquinone forms. The stability of these semiquinone forms is crucial in determining the protective or antioxidant effect of plant phenols. Studies have shown that compound 1 and 15 can significantly eliminate DPPH• radicals, with a dose-dependent scavenging ability at concentrations of 0.5~100 μM. Compound 10 has also been found to possess high radical scavenging effects, with an IC_{50} value of 3.491 μg/mL. The number and site of the OH groups in these compounds appear to be primary factors affecting their antioxidant abilities. For instance, the ortho-hydroxyl group in compound 10 reacts with free radicals to form a more stable conjugated semiquinone radical, thereby interrupting the free radical chain reaction and exhibiting stronger antioxidant properties. Compound 5 has also been found to exhibit scavenging effects on DPPH• radicals, although with an IC_{50} value of 26.56 μg/mL. A comparative study involving compounds 10 and 11 revealed that compound 10 had the greatest scavenging activity, followed by compound 11. The general mechanism for scavenging •OH radicals involves a radical adduct formation process, where a radical adduct with phenol is formed, followed by the elimination of water molecules. Alternatively, scavenging of DPPH• can occur through the abstraction of hydrogen atoms from antioxidants or the transfer of electrons from phenoxide anions to DPPH• In addition, the lipid peroxidation reaction, which involves the initiation of free radical formation in cells and tissues, has been found to be inhibited by anthraquinone compounds. The order of inhibitory activities was reported to be anthrone compound > 2 > 3 > 1 > anthraquinone. However, other reports suggest that these anthraquinone compounds exhibit good antioxidant properties against lipid peroxidation. The research explores the potential benefits of anthraquinone compounds in various biological processes, including oxidative stress reduction, cytotoxicity prevention, and inflammatory inhibition. The studies found that certain compounds could effectively combat cellular damage caused by cisplatin, hydrogen peroxide, or lipopolysaccharide. For instance, Compound 1 was shown to restore GSH and TAC levels, as well as enhance antioxidant enzyme activity in human embryonic kidney cells. Similarly, Compound 2 prevented cytotoxicity in PC12 cells by reducing NO release and ROS accumulation, while Compound 3 increased the viability of HUVECs by downregulating MDA and LDH and upregulating NOS and GSH-PX. Additionally, studies have demonstrated that metal complexes often exhibit enhanced antioxidant activity compared to individual ligands. The combination of traditional Chinese medicine active ingredients with metal ions can produce synergistic effects. Our research found that metal complexes exhibited higher antioxidant activities than the ligand alone. Furthermore, various reports investigated the antioxidant properties of metal complexes of Compound 1, including Cu(II), Fe(II), Zn(II), Mg(II), and Mn(II). The results showed that all these metal complexes displayed higher antioxidant activities than the original ligand. The coordination of the 9-carbonyl group and 1-phenolic hydroxyl group in Compound 1 forms a stable hexacoordinated ring structure with metal ions, enabling the transfer of the active center from the hydroxyl group to the metal ion. The electron donor sites, including C=O and phenolic hydroxyl groups, can be coordinated with metals, leading to the splitting of merged orbitals into different energy levels. Given article text here After absorbing electromagnetic wave energy, electrons can move from low-energy d orbitals to high-energy d* orbitals, producing absorption bands in the visible region. Anthraquinone compounds contain metal chelation sites due to their large π-conjugated system and strong coordination of oxygen atoms. This makes them effective ligands for metal ions to form complexes [50,73]. Studying anthraquinone's structural modifications can improve its antioxidant activity. The type of substituent affects the scavenging ability, mainly by stabilizing free radicals [91]. Comparing compounds 17a and 18, which have different parent structures but the same substituent group, showed that compound 18 had higher antioxidant capacity than compound 17a. This was likely due to the lower electronegativity of sulfur atoms compared to oxygen atoms, resulting in stronger reducing capacity and increased antioxidant activity [92]. Compounds 17a-e share a similar structure with varying R groups, and their antioxidant activities were found to be related to chain length. When phenyl substitution was introduced, the conjugation system between the phenyl group and parent structure increased antioxidant activities due to enhanced π-conjugation [92]. However, compound 17c exhibited lower inhibition due to steric hindrance caused by ortho-substitution [92]. Anthraquinones exhibit a wide range of biological activities and can treat various diseases such as Alzheimer's disease, inflammation, cancer, liver injury, diabetes, gastrointestinal disorders, ulcers, radiation injury, and burns [93-95]. They have strong abilities to scavenge free radicals and prevent oxidative damage to tissues [96]. Although the relationship between antioxidant mechanism and activity in vivo is not fully understood, bioactivity and pharmacokinetic studies provide valuable information. The enhancement of antioxidant enzyme activity may relate to anthraquinones' redox activity or ability to bind specific proteins. Oxidative stress plays a crucial role in Alzheimer's disease development and progression [97]. It disrupts calcium homeostasis and leads to apoptosis, contributing significantly to the pathogenesis of Alzheimer's disease [98]. Clinical studies have reported strong evidence for oxidative stress involvement in Alzheimer's disease. Compound 1 showed inhibition of Aβ42 fibrillogenesis and Aβ-induced toxicity [99]. Chen et al. found that compound 1 has neuroprotective effects by reducing ERK1/2 phosphorylation, decreasing ROS, and protecting mitochondrial function. Tao et al. discovered that compound 2 may have a role in cognitive deficits in a scopolamine-induced amnesia animal model, while increasing SOD, GPX, and acetylcholine but decreasing MDA and acetylcholinesterase activity. This suggests compound 2 might have a neuroprotective effect on Alzheimer's disease by inhibiting acetylcholinesterase and regulating oxidative stress. Zhao et al. found that compound 5 reduced neuronal damage in a mouse middle cerebral artery occlusion model by reducing nitric oxide production and enhancing SOD and manganese-dependent SOD activity. Zhang et al. discovered that compound 5 alleviated hippocampal neuronal injury, decreased MDA levels, and increased SOD and GPX activity in lead-exposed neonatal mice. The study also reported that oxidative stress is associated with carcinogenesis by causing DNA degradation, increasing free radicals, and reducing nuclear factor erythroid 2-related factor 2 signaling. Compound 1, when combined with cisplatin, inhibited the growth of human ovarian and gallbladder carcinoma cells in vivo, possibly through downregulating MRP1 expression. Wang et al. found that compound 1 induced necroptosis by activating JNK signaling pathway and inhibiting glycolysis by downregulating GLUT1 expression. The study also highlighted the role of oxidative stress in liver inflammation, fibrosis, and hepatocellular carcinoma. The antioxidation activities of certain compounds have been connected to the inhibition of contractile effects and the enhancement of diastolic effects related to up-regulation of free radicals, hydrogen peroxidation, and cGMP. Inflammatory responses produce a large amount of reactive oxygen species (ROS) and are associated with various diseases. The NF-κB transcription factor family plays a central role in mediating the inflammatory process and participating in immune responses. Studies have shown that ROS or metals can affect nuclear NF-κB transcription factors, leading to the activation of NF-κB and the subsequent regulation of inflammatory cytokines. Given article text here Rhubarb Decoction Metabolism and Bioavailability The metabolites of rhubarb decoction were identified in rat urine, bile, and plasma. Compounds 1-5 may be metabolized into sulfonated forms. Compound 2 was transformed to glucoside derivatives through hydroxylation, hydrogenation, and glucuronidation. Oxidation increased anthraquinone bioavailability. The order of anthraquinone bioavailability was: compound 3 > compound 1 > compound 5 > compound 2. This may result from compounds 2 and 5 being oxidized to compound 3. Sulfonated forms may decrease oral bioavailability. Anthraquinones are not only phenols but also p-quinones. Oxidation of phenols generates quinones, which undergo enzyme-catalyzed reduction reactions producing semiquinone or hydroquinone. The redox cycle leads to oxidative stress. After oral administration, anthraquinones are absorbed into the blood, combined with glucuronic acid, and transported to various tissues. They undergo oxidation, methylation, esterification, and glycosidation. Anthraquinones have biological activity but low solubility and rapid elimination rate limit their use. Side effects include genotoxicity, nephrotoxicity, and hepatotoxicity. Improving bioavailability through structure modification or drug dosage form changes is necessary for safe and effective clinical applications. Three structural characteristics of anthraquinone compounds are closely linked to their antioxidant activity: the benzene ring and carbonyl group, the number and position of hydroxyl groups, and the position and number of other substituents. The benzene ring is hydrophobic, while the phenolic hydroxyl group is hydrophilic. Anthraquinone compounds can be roughly divided into two types: emodin type and alizarin type. Emodin-type compounds have distributed hydroxyl groups on both sides of the benzene ring, whereas alizarin-type compounds have distributed hydroxyl groups on one side. The antioxidant activity of anthraquinones is mainly related to phenolic hydroxyl groups. There are three main mechanisms: HAT, SET-PT, and SPLET. Experimental results support these mechanisms. The structural characteristics that affect antioxidant activity include the position and number of phenoxyl groups, the position of other substitutions, and the carbonyl group on the parent structure. For example, when the carboxyl group is ortho-positioned to the hydroxyl group or the methoxyl group is meta-positioned, they act as electron-withdrawing groups, increasing IP values and decreasing antioxidant activity. The carbonyl group can also work as a chelating site to coordinate with Fe(II) or Cu(I) ions, terminating the Fenton reaction. Anthraquinones are widely distributed in various botanicals, such as rhubarb, aloe, and Fo-Ti, which have been clinically used in traditional medicine. Antithraquinones in Medicines and Dietary Supplements Various compounds, such as 1, 2, and 3, have been found in rhubarb, Fo-Ti, and aloe. These compounds are used in traditional Chinese medicines and dietary supplements. Natural anthraquinones have biological activities, commonly found in plants and microorganisms. Anthraquinone (1) has strong antioxidant properties. Anthraquinones can modulate antioxidants enzymes and systems to reduce oxidative stress. However, more research is needed in this field. Firstly, the side effects of anthraquinone compounds are not well understood. Although some anthraquinone drugs have been successful, their absorption and metabolism need further study. Secondly, new treatments for diseases related to ROS need development. Further studies on the mechanism of anthraquinones are necessary, especially regarding the relationship between concentration and ROS mediation properties. Reactive Oxygen Species (ROS) Induced Cell Apoptosis and its Potential for Anthraquinone Compounds Treatment Anthraquinone compounds have been studied for their potential therapeutic effects, particularly in relation to reactive oxygen species (ROS). Emodin, a naturally occurring anthraquinone compound, has been shown to induce mitochondria-induced cell apoptosis associated with ROS generation. Conversely, some studies suggest that decreasing ROS levels may be beneficial in treating diseases using anthraquinone compounds. In certain cases, however, the treatment of diseases with anthraquinone compounds may lead to an increase in ROS levels, which can induce autophagy and apoptosis in cancer cells. For instance, Anthraquinones have been reported to increase ROS and reduce antioxidant enzyme activities, thereby promoting cell death in cancer cells. The results of this study provide valuable insights into the antioxidant mechanism of anthraquinone compounds, as well as its potential for guiding the study of other natural products with similar structures. Recent studies have shed light on the role of oxidative stress and antioxidants in various diseases. Oxidative stress has been implicated in the pathogenesis and progression of Alzheimer's disease, while also playing a crucial role in liver diseases, atherosclerosis, and cancer. Antioxidants have been shown to have anti-inflammatory effects, suppress reactive oxygen species (ROS), and regulate oxidative stress. Researchers have also explored the potential therapeutic benefits of anthraquinones, such as emodin, which has been found to have antioxidant and anticancer properties. Additionally, studies on shikonin, a naphthoquinone pigment, have shown its ability to scavenge peroxyradicals in cigarette smoke. Other studies have investigated the effects of antioxidants in vascular health and diseases, with some findings suggesting that certain compounds may help prevent liver fibrosis, inflammatory response, and oxidative stress. The use of natural products such as dandelion, Polygonum cuspidatum, and Rhamnus species has also been explored for their potential antioxidant and anti-inflammatory properties. Overall, the research highlights the importance of understanding the role of oxidative stress and antioxidants in various diseases, and how this knowledge can be used to develop new therapeutic strategies. The methanolic extracts of three Salvia species from Tunisia were found to possess antimicrobial and antioxidant activities. The extracts demonstrated significant inhibitory effects against various microorganisms, including bacteria and fungi. Additionally, they showed antioxidant properties, potentially contributing to their antimicrobial activities. Several studies have investigated the binding interactions between anthraquinones and bovine β-lactoglobulin. The results suggest that these compounds can form complexes with the protein, which may influence their bioavailability and biological effects. Quinones derived from plant secondary metabolites have been identified as potential anti-cancer agents. These compounds have been shown to exhibit cytotoxicity against various cancer cell lines. The toxicity and antioxidant capacity of Frangula alnus Mill. bark and its active component emodin were evaluated. The results indicate that the bark extract possesses antioxidant properties, while emodin demonstrated significant toxicity towards certain cell lines. Three anthraquinones (alizarin, purpurin, and quinizarin) were found to possess antioxidant, enzyme inhibition, and cytotoxic activities. These compounds may have potential therapeutic applications. Structurally diverse metabolites from Ophiorrhiza japonica Bl. and their antioxidant activities in vitro and PPARα agonistic activities in silico were investigated. The results suggest that these compounds may be useful for the development of new drugs. Rubiadin, a promising natural anthraquinone, has been identified as a potential lead compound for drug discovery and development. Its chemistry, biosynthesis, physicochemical, and biological properties make it an attractive candidate for further study. Free radicals are involved in various biological processes, including aging and disease. Antioxidants play a crucial role in neutralizing these radicals and protecting against oxidative stress. Several studies have investigated the mechanisms of free radical-mediated aging and the potential therapeutic applications of antioxidants. The antioxidant activity of a triterpenoid glycoside isolated from Hedera colchica berries was evaluated, suggesting that this compound may be useful for the prevention of oxidative stress-related disorders. **The Role of Antioxidants in Human Health** Antioxidants play a crucial role in maintaining human health by neutralizing free radicals, which can cause oxidative stress and contribute to various diseases. Research has shown that antioxidants can help prevent or treat conditions such as Alzheimer's disease, Parkinson's disease, and certain types of cancer. **Natural and Synthetic Antioxidants** Studies have identified both natural and synthetic compounds with antioxidant properties. Natural antioxidants include phloroglucinol, which has been shown to improve cognitive function by reducing amyloid beta peptide burden in mice. Other natural compounds, such as chromones, coumarins, and flavones, have also demonstrated antioxidant activity. **Metal Ions and Oxidative Stress** The presence of metal ions can lead to oxidative stress, which contributes to the development of various diseases. Research has shown that certain metal ions, such as iron and copper, can induce free radical formation and contribute to neurodegenerative diseases like Alzheimer's. **Antioxidant Strategies against Metal Exposure** To mitigate the effects of metal exposure, antioxidants have been proposed as a potential strategy. Compounds with antioxidant properties can help neutralize free radicals generated by metal ions, reducing oxidative stress and associated health risks. **New Insights into Antioxidant Mechanisms** Recent studies have shed new light on the mechanisms underlying antioxidant activity, including the role of thermodynamics in sequential proton-loss electron-transfer reactions. Research has also explored the effects of C-glycosylation and hydroxyl groups on antioxidant activity. Overall, this paraphrased text highlights the importance of antioxidants in maintaining human health, the potential benefits of natural and synthetic compounds with antioxidant properties, and the need for further research into the mechanisms underlying antioxidant activity. Researchers have extensively studied the free radical scavenging potency of various natural compounds, with a focus on their mechanisms of action. Studies have shown that certain polyphenolic antioxidants, such as ellagic acid and its derivatives, exhibit potent antioxidant properties in various biological systems. The molecular basis of these effects has been elucidated through detailed structural and electronic analyses. Furthermore, researchers have investigated the influence of chemical structures on the radical scavenging activity of flavonoids and anthraquinones, revealing specific structural features that contribute to their antioxidant potency. These findings have implications for the design and development of novel antioxidants with improved efficacy. Additionally, studies have explored the theoretical aspects of antioxidant reactivity, including the role of sequential proton loss electron transfer in hydrogen atom abstraction reactions. These investigations have shed light on the complex chemistry underlying antioxidant behavior. The text also mentions various compounds with reported antioxidant properties, including Aloe vera components, anthraquinones, and flavonoids. Overall, the studies collectively demonstrate the importance of structural features and chemical mechanisms in determining the efficacy of natural antioxidants. A series of studies have investigated the antioxidant and scavenging properties of various compounds, including emodin, aloe-emodin, rhein, anthraquinones, purpurin, and anthrone. These studies found that these compounds can protect against oxidative stress and DNA damage caused by free radicals and reactive oxygen species in different cell lines. Some specific findings include: * Emodin and aloe-emodin have been shown to have antioxidant and scavenging activities against hydroxyl radicals. * Anthraquinones have been found to ameliorate oxidative stress in various in vitro assays. * Purpurin has been demonstrated to have antioxidant and anti-inflammatory properties. * A study on the effects of anthraquinone derivatives on lipid peroxidation in rat heart mitochondria found a structure-activity relationship. These compounds have also been shown to protect against cytotoxicity and memory impairment caused by different agents, including scopolamine and H_2O_2. Overall, these studies suggest that emodin, aloe-emodin, anthraquinones, and other related compounds may have potential therapeutic applications as antioxidants and scavengers of free radicals. Several studies have investigated the effects of various compounds on oxidative stress-related injuries and diseases. For example, one study found that rhein can protect endothelial cells from injury caused by oxidative stress. Another study showed that chrysophanol can suppress inflammation in microglia cells by regulating mitochondrial fission. Additionally, research has demonstrated that purpurin can alleviate alcohol-induced liver damage by reducing reactive oxygen species (ROS) generation and promoting the expression of Nrf2. In the context of neuroprotection, one study found that purpurin can help prevent ischemic damage in the hippocampus by modulating MAPKs, Bax, and oxidative stress pathways. Another study demonstrated that xanthone derivatives can have anti-Alzheimer's disease activity through a multi-target strategy. Furthermore, researchers have designed and synthesized various compounds, including naringenin carbamate derivatives and chrysin derivatives, which have shown potential as multifunctional agents for treating Alzheimer's disease. The antioxidant activity of emodin-copper(II) metal complex has also been studied, along with the anti-cancer effects of emodin-Mn(II) metal complex. Finally, one study compared the antioxidant activity of glucans and found that while they exhibited weak antioxidant activity, they could stimulate macrophage free radical activity. Overall, these studies highlight the importance of understanding the mechanisms underlying oxidative stress-related injuries and diseases, as well as the potential therapeutic benefits of various compounds. Research has shown that anthraquinones and anthracenes derivatives have anti-inflammatory and cytotoxic effects in human white blood cells. These compounds are found in plants such as Aloe vera, which has been used for medicinal purposes. Studies have also investigated the antibacterial properties of South African plants and the separation and purification of aloe anthraquinones using various methods. Furthermore, research on quinone derivatives from the genus Rubia has revealed their bioactivities, including anti-inflammatory and antioxidant effects. Oxidative stress has been linked to Alzheimer's disease, and studies have explored the role of ion homeostasis and apoptosis in this condition. Emodin, a compound found in plants such as Aloe vera, has been shown to inhibit the aggregation of amyloid-β peptide 1-42 and improve cognitive deficits in Alzheimer's disease transgenic mice. Emodin has also been found to protect cells against oxidative stress and inflammation through various pathways. Additionally, chrysophanol, another compound found in plants, has been shown to attenuate nitrosative/oxidative stress injury in a mouse model of focal cerebral ischemia/reperfusion. Chrysophanol has also been found to attenuate lead exposure-induced injury to hippocampal neurons in neonatal mice. Reactive oxygen species (ROS) have been linked to cancer, and the Nrf2 pathway plays a crucial role in regulating antioxidant responses. Oxidative stress, inflammation, and cancer are interconnected processes that are influenced by various factors, including ROS and the Nrf2 pathway. Finally, emodin has been found to augment cisplatin cytotoxicity in platinum-resistant ovarian cancer cells via ROS-dependent MRP1 downregulation, suggesting potential therapeutic applications for this compound. Emodin has been shown to be effective in targeting cancer stem-like cells in gallbladder carcinoma. It also induces necroptosis and inhibits glycolysis in renal cancer cells by enhancing ROS. Additionally, emodin inhibits oxidative stress in the liver via AMPK with Hippo/Yap signaling pathway. Furthermore, it prevents intrahepatic fat accumulation, inflammation, and redox status imbalance during diet-induced hepatosteatosis in rats. In vivo antioxidant action of emodin has been compared to schisandrin B and other compounds. Cardiovascular and airway relaxant activities have also been demonstrated for emodin. NF-κB and the link between inflammation and cancer have been studied, as well as molecular recognition of 15-deoxy-delta(12,14)-prostaglandin J2 by nuclear factor-kappa B and other cellular proteins. Malondialdehyde and superoxide dismutase have been explored as potential markers of severity in acute pancreatitis. Oxidised lipids present in ascitic fluid interfere with the regulation of macrophages during acute pancreatitis, promoting an exacerbation of the inflammatory response. The role of nuclear factor kappaB and mitogen-activated protein kinase signaling in exercise-induced antioxidant enzyme adaptation has been investigated. Emodin has also been shown to attenuate severe acute pancreatitis via antioxidant and anti-inflammatory activity. Several studies have investigated the effects of dietary emodin on various biological processes. Emodin, a compound found in certain plants, has been shown to attenuate lung injury caused by cigarette smoke in mice. Additionally, it has been found to prevent nerve damage and neuroinflammation caused by ischemic stroke. Moreover, chrysophanol, another plant-derived compound, has been demonstrated to protect against liver injury through the RIP140/NF-κB pathway. Researchers have also explored the pharmacokinetics of anthraquinones, a class of compounds found in medicinal plants. Studies have employed various analytical techniques, such as liquid chromatography and mass spectrometry, to quantify the levels of these compounds in biological samples, including plasma and liver tissue. Furthermore, there have been studies on the metabolism of anthraquinones in rats and ex vivo antioxidant activity. These findings suggest that anthraquinones undergo significant metabolism in the body, with some compounds being converted into other forms that retain their bioactive properties. Overall, this research highlights the importance of understanding the pharmacokinetics and metabolism of plant-derived compounds, such as emodin and chrysophanol, to better appreciate their potential therapeutic effects. Researchers have studied the metabolic differences of anthraquinone derivatives using liquid chromatography/tandem mass spectrometry with data-dependent acquisition. They found that san-huang-xie-xin-tang, a Chinese medicine formula, has antioxidant activity in rats and ex vivo. Anthraquinones are pharmacological tools and drugs that have been studied for their effects on the body. Some studies have compared raw and processed Radix Polygoni Multiflori (Heshouwu) using high performance liquid chromatography and mass spectrometry. Others have investigated the participation of cathepsin B in emodin-induced apoptosis in HK-2 cells. There is concern about the genotoxicity of naturally occurring hydroxyanthraquinones, which can cause damage to DNA. To address this issue, researchers have developed a tiered in silico QSAR approach that incorporates absorption and metabolism into liver toxicity prediction for phytochemicals. Pharmacokinetic studies have been conducted on anthraquinones in rat plasma after oral administration of a rhubarb extract. The results show that the pharmacokinetics and pharmacodynamics of rhubarb anthraquinone extracts vary depending on the disease state of the rats. Researchers have also explored the therapeutic potential of rhubarb in targeting foam cell formation and macrophage polarization in atherosclerosis. Additionally, there is concern about liver injury caused by ingestion of Polygonum multiflorum, which has been reported in 18 cases. Finally, there are ongoing studies on the biomedical applications of Aloe vera, including its potential anticancer effects. **Introduction** Research on anthraquinone compounds has revealed their potential in combating cancer and other diseases. These compounds have been found to possess antioxidant properties, which can help protect against oxidative stress. **Phytochemical Constituents** Studies have identified various phytochemical constituents present in Aloe species, including aloe-emodin, aloesone, and isoeleutheol. These compounds have shown radical scavenging activity, suggesting their potential use as antioxidants. **Computational Modeling** Computational modeling has been used to study the reactivity descriptors and antioxidant behavior of crocin, a compound found in saffron. This research provides valuable insights into the mechanisms underlying the antioxidant properties of anthraquinone compounds. **Antioxidant Activities** Experiments have demonstrated the antioxidant activities of various anthraquinone compounds, including emodin, aloe-emodin, rhein, chrysophanol, purpurin, and others. These studies show that these compounds can inhibit superoxide production in human neutrophils and modulate various cellular processes. **Metabolic Pathways** Research has also investigated the metabolic pathways of anthraquinones, including glucuronidation, oxidation, hydroxylation, hydrogenation, and sulfation. The resulting metabolites have been identified, providing a better understanding of how these compounds are processed in the body. **Summary** In summary, this research highlights the potential benefits of anthraquinone compounds as antioxidants and their possible use in cancer treatment. The studies presented provide valuable insights into the mechanisms underlying their antioxidant properties and offer a deeper understanding of their metabolic pathways. The text discusses the properties and effects of various anthraquinone compounds, including hydroxy-rhein, aloe-emodin, rhein, physcion, and chrysophanol. These compounds are found in plants such as rhubarb (Rheum officinale), Fo-Ti (Polygonum multiflorum), Aloe vera (Aloe barbadensis), and others. The text lists the effects of these compounds on various health conditions, including: * Tumor * Inflammation * Gastrointestinal disease * Hepatoprotective activity * Diabetic nephropathy * Atherosclerosis It also mentions the potential for these compounds to have anticancer properties and to be used as neutraceuticals. The text provides data on the levels of these compounds in different botanical sources, including rhubarb, Fo-Ti, and Aloe vera. The data suggests that these compounds can be found in various forms and amounts in these plants, depending on factors such as dosage and preparation method. Overall, the text highlights the potential health benefits of anthraquinone compounds and their importance in traditional medicine and herbal remedies. We cannot verify the accuracy of any claims made in this text as it appears to be legally disclaiming liability for any potential damages resulting from its content.