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MINI REVIEW

Role of medicinal plants as antioxidants in the treatment of oxidative stress-related human health disorders

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ABSTRACT

Oxidative stress refers to an imbalance between the production of free radicals, also known as reactive oxygen species, and the body's ability to neutralize or detoxify them within a biological system. Although free radicals are essential for several physiological functions and cell signalling, excessive production triggered by factors such as stress, xenobiotic drugs, unhealthy lifestyle habits, and poor diet can lead to oxidative stress. While the human body possesses natural defence mechanisms to counter oxidative stress to a certain extent, uncontrolled levels of free radicals can disrupt normal bodily functions, causing damage to cells and tissues. This disruption can have negative implications on the body's overall function, potentially resulting in the development of various chronic disorders. These disorders encompass inflammatory diseases, cardiovascular diseases, atherosclerosis, arthritis, cancer, neurodegenerative disorders, and diabetes, among others. Antioxidants play a pivotal role in mitigating the effects of oxidative damage. They are substances that counteract the toxic impact of free radicals within cells, thereby promoting overall health. Natural antioxidants derived from plants are particularly instrumental in reducing oxidative stress within the human body. Compounds like flavonoids and phenolics found in medicinal plants act as essential defenders against stress-induced cellular damage. Consequently, these antioxidants contribute to the treatment of stress-related ailments, including neurodegenerative problems, cardiovascular diseases, diabetes, hyperlipidaemia, atherosclerosis, and cancer – conditions that hold significant prevalence in modern-day society.

INTRODUCTION

The oxidation process is one of the most important routes for producing free radicals and reactive oxygen species (ROS), in food, drugs and living systems. Reactive oxygen species (ROS) such as singlet oxygen ($^{\cdot}O_2$), superoxide anion (O_2^-), hydroxyl (.OH) radical and hydrogen peroxide (H_2O_2) are often generated as a byproduct of biological reactions. These reactive oxygen species exert oxidative damaging effects on human health by reacting with important bio-molecules present in living cells including DNA, lipids, and protein if excess ROS are not eliminated by the antioxidant system (Kruk *et al*., 2019).

When an imbalance occurs between oxidants and antioxidant defence systems, oxidative stress occurs. This oxidative stress in cells results in severe metabolic dysfunctions, including loss of cell integrity, enzyme function, genomic stability, and so forth, which ultimately lead to the pathogenesis of

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many human diseases (e.g., inflammation, ischemia, atherosclerosis, arthritis, cancer, Parkinson's disease, Alzheimer's disease, and so forth) (Luo *et al*., 2020). So, on, there has been an upsurge of interest in the therapeutic potential of plants as antioxidants in reducing such free radical-induced tissue injury. Plant extracts and plant products such as flavonoids and polyphenolic constituents have been reported to be effective radical scavengers and inhibitors of lipid peroxidation. Many synthetic antioxidant compounds have shown toxic and/ or mutagenic effects, which have stimulated the interest of many investigators to search the natural antioxidants originating from plants having free radical scavenging properties. Besides well-known and traditionally used natural antioxidants from tea, fruits, vegetables and spices, medicinal plants are highly exploited commercially as a major source of antioxidants and nutritional supplements. Several studies have demonstrated the hypotensive, hypolipidemic, hypoglycemic, anticancer, antioxidant and anti-inflammation properties of certain Indian medicinal plants (Wangensteen *et al*., 2004; Prasathkumar *et al*., 2021; Luthra and Roy, 2022). So on, medicinal plants with high antioxidant potential play an important role in the treatment of various stress-related disorders; i.e., diabetes, hyper-lipidaemia, atherosclerosis, and neuro-degenerative and cardiac-related diseases; which are becoming major health problems nowadays (Kruk *et al*., 2019; Luthra and Roy, 2022). Oxidative stress-induced ROS generation and the defensive role of antioxidants from medicinal plant sources against stress-related health issues are diagrammatically presented here in Figure 1.

Review of Status of Research & Development

National Status

In India, several investigators have worked in this specific context in assessing the antioxidant capacity of herbal medicinal plants (Chanda and Dave, 2009; Kaur *et al*., 2008; Ali *et al*., 2008; Kumar *et al*., 2022). Prakash *et al*., (2007) have identified the total phenol, antioxidant and free radical scavenging activities of some Indian medicinal plants (*Azadirachta indica, Cassia fistula, Casuarina equisetifolia, Indigofera tinctoria, Lawsonia inermis*, *Trewia nudiflora*) having high phenols and high antioxidant activity. Kshirsagar and Upadhyay (2009) have studied the anti-oxidative effects of 32 plant species from Tripura, northeastern India and observed that 16 of them showed higher antioxidant potential depending on their dose-dependent activity. Among them, *Mitragyna rotundifolia, Schimawa lichii, and Syzigium cerasoides* have rich antioxidant potential. Jain *et al*., (2010) from Gujrat have studied *Alangium salvifolium* and reported that the extract from its roots has interesting potential free radical scavenging activity for the treatment of diseases. Patel *et al*., (2010) worked on the antioxidant activity of some selected medicinal plants from the western region of India and screened

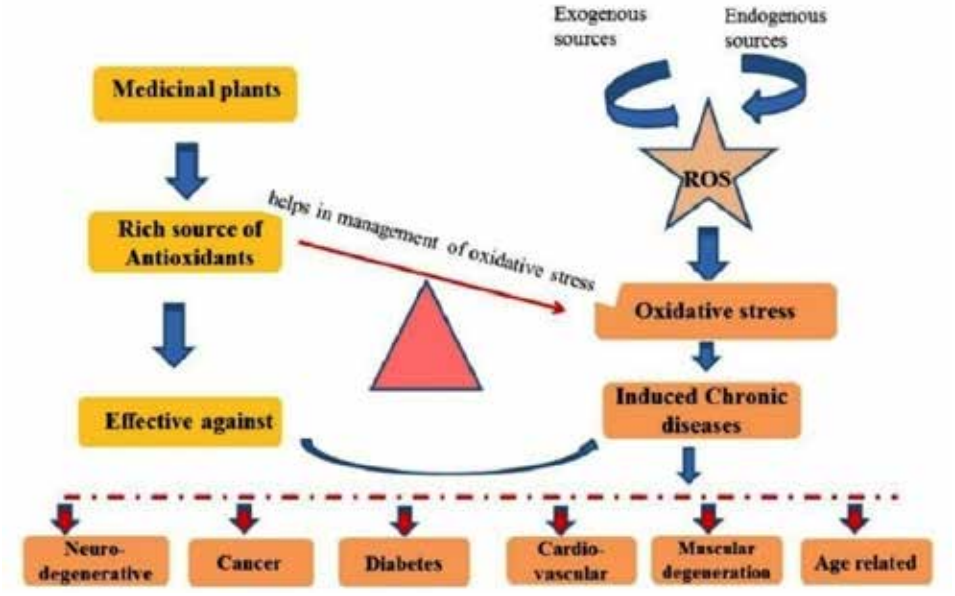

Figure 1: Antioxidant potency of medicinal plants against oxidative stress induced human health problem

Table 1: Medicinal Plants, bioactive components with Known Beneficial Effects against various oxidative stress-related human disorders

S. No.	Botanical name	Common name	Bioactive metabolites	Against Oxidative stress disorders	Reference
1.	*Digitalis purpurea* *Digitalis lanata*	Purple Foxglove Grecian foxglove	Cardiac glycosides	Cardio-tonic, relaxing cardiac problems	da Chunga *et al*., (2006)
2.	*Convallaria majalis*	lily-of-the-valley	Convallotoxin	Cardio-tonic	Higano *et al*., (2007)
3.	*Hibiscus sabdariffa*	Roselle	polyphenolic acids, flavonoids, protocatechuic acid, anthocyanins	diabetic nephropathy	Lee *et al*., (2009)
4.	*Crataegus pinnatifida*	mountain hawthorn	phenolic, flavonoid, and tannin	neuroprotective effect	Chang *et al*., (2013)
5.	*Aegle marmelos,* *Cinnamomum zeylanicum* *Gymnema sylvestre* *Limonia acidissima*	Bael Cinnamon Gurmar Wood apple	Plant extract (no specific metabolites mentioned)	Anti-diabetic effect	Vidyasagar and Siddalinga (2013)
6.	*Morus alba*	white mulberry	flavonoids, polysaccharides, alkaloid	anti-diabetic properties	Jeszka-Skowron *et al*., (2014)
7.	*Plantago maxima*	Giant Plantain	flavonoids, iridoids, phenol carboxylic acids, tannins, ascorbic acid	potent anti-obesity activity	Tinkov *et al*., (2014)
8.	*Bacopa monnieri* *Centella asiatica,* *Mucuna pruriens* *Withania somnifera*	Brahmi, *Indian pennywort* Velvet bean Ashwagandha	Withanine, somniferine, somniferinine, Withanamides Bacosides, asiatic acid, asiaticoside, Tannins, alkaloids, L-dopa	Against Neurodegenerative disorders	Mannangatti and Naidu (2016)
9.	*Artemisia dracunculus*	tarragon	estragole, phellandrene, tannins, methyl coumarins, chavicol, rutin	Against stomach pains, pyrexia, anti-diabetes, anti-bacterial effects	Munivand *et al*., (2017)
10.	*Baccopa monnieri* *Curcuma longa* *Ginkgo biloba,* *Panax ginseng* *Vitis vinifera,* *Withania somnifera,*	Brahmi Turmeric Gingko Ginseng Grape Ashwagantha	Withanolides, Ginsenoside (a saponin), Curcumin, , resveratrol, Ginkgolide, Bilobalide, Bacoside A and B, Betulic acid,	Against Neurodegenerative diseases related to ageing, such as Alzheimer's disease (AD) and Parkinson's disease	Ratheesh *et al*., (2017)
11	*Salvia miltiorrhiza*	Red sage	Salvianolic acid	cardio- vascular-protective potential	Li *et al*., (2018)
12.	*Catharanthus roseus* *Murraya koenigii*	Madagascar periwinkle Curry Leaf Tree	Terpenoid indole alkaloids (Ajmalacine, vincristine, vinblastine) a carbazole alkaloid (girinimbine)	Anti-cancer (breast cancer) effect	Harshini *et al*., (2020)
13.	*Taraxacum officinale*	Dandelion	Cinnamic acid, coumarins and flavonoids	diuretic, anti-rheumatic and anti-inflammatory	Tajner-Czopek *et al*., (2020)
14.	*Vitis vinifera*	Red grapes	Resveratrol, flavonoids, anthocyanins, stilbenes etc.	reduced incidence of hypertension and cardiovascular diseases	Sabra *et al*., (2021)
15	*Astragalus membranaceus* *Abelmoschus manihot* *Salvia miltiorrhiza* *Vitis vinifera* *Zingiber officinale*	Astragalus Sunset Hibiscus Salvia Grape Ginger	Various bioactive compounds, including amino acids, polysaccharides, organic acids, trace elements, nucleosides, peptides, steroids etc.	Chronic Kidney Disease	Khan *et al*., (2022)

the high radical scavenging activity in the stem of *Kigelia* followed by the leaf of *Hibiscus and Gemelia.* Penumala *et al*., (2018) studied phytochemical profiling and evaluating the multifunctional ability of *Buchanania axillaris*, *Hemidesmus indicus* and *Rhus mysorensis* in Alzheimer's disease and Type 2 Diabetes Mellitus and reported its significant role in dual therapy. In Recent research, a novel phenanthrene derivative compound(s) has been isolated from *Grewia tiliaefolia* Vahl. by Rajput *et al*., (2023) and they reported the neuroprotective activity of this compound in relief of Alzheimer's disease. These findings state that novel therapeutic drugs derived from medicinal plants act effectively in the prevention and treatment of various chronic diseases such as; neuro-degenerative problems, cardiovascular diseases, cancer, diabetes etc. (Lal and Lal, 2020; Ray and Saini, 2021; Sharma *et al*., 2022; Reddy and Nagendra, 2022).

International Status

At an international level, several studies from

different countries have confirmed the antioxidant activity in different plants of medicinal importance (Kruk *et al*., 2019; Sekhon-Loodu and Rupasinghe, 2019). Fenglin *et al*., (2004) reported the free radical scavenging activity from leaves of 300 Chinese medicinal woody plants and screened, 56 species that had strong free radical scavenging capacities. Analysis of the medicinal uses of these plants showed that most of them are employed for their effects on homeostasis, as anti-inflammatory, and antimicrobial, for treatment of dysentery. Their medicinal uses may be directly linked to the content of tannins and flavonoids and consequently to their free radical scavenging activities. Gyamfi *et al*., (1999) worked on the free-radical scavenging action of medicinal herbs from Ghana and based on observation they suggest the protective action of *Thonningia sanguinea* on liver injuries due to the result of direct action as a free-radical scavenger and antioxidant, affording protection against oxidative stress. Zakaria, (2007) studied on free radical scavenging activity, of the leaf extract of several plants found in Malaysia, namely *Muntingia calabura*; *Bauhinia purpurea*; *Dicranopteris linearis*; *Melastoma malabathricum*; *Corchorus capsularis* and identified the biochemical compounds (Flavonoids, triterpenes, saponins and tannins) responsible for the observed antioxidant activity. Pourmorad *et al*., (2006) carried out a systematic record of the relative antioxidant activity in selected Iranian medicinal plant species' extracts and noticed that a greater amount of phenolic compounds leads to the highest radical scavenging effects in *Mellilotus officinalis*. Available literature well explained that higher antioxidants in medicinal plants correlate with their health-protective role in combating various oxidative stress-related chronic diseases i.e., neuro-degenerative disorders, cardiac problems, diabetes, cancer etc. with slight or no side effects (Eddouks *et al*., 2013; Hussain *et al*., 2018; Mostafa and Abdellatif, 2020; Moreira *et al*., 2023). Raimi *et al*. (2020) have documented the available published literature reporting on plant species used for the treatment of cancer over the past twenty years (1998 – 2018) in Africa and reported that out of a total of 207 plant species recorded, forty-eight per cent (48%) of the documented plant species were reported with cytotoxic activity against different cancer cell lines. Shabab *et al*., (2021) from Iran demonstrated the role of medicinal plants in the cardio-protective manifestations in diabetic patients to restore cardiovascular complications. The role of different plants along with their bioactive components and their therapeutic role against various stress disorders of human health are documented in Table 1.

SIGNIFICANCE

A systematic screening of the antioxidant potential of medicinal plants could be of great significance. This article reviewed on antioxidant potential of medicinal plants and its therapeutic uses against stress-related human health problems. This study must broaden the knowledge regarding antioxidants and medicinal active metabolites' role from different medicinal plant sources in combating and managing oxidative stress-related chronic disorders, having least or no side effects.

HIGHLIGHTS

- Free radicals arising in the human body either endogenously or via exogenous sources, cause oxidative stress.
- Oxidative stress is a major contributor to various chronic diseases, including cancer, neurodegenerative disorders, cardiovascular diseases, diabetes problems etc.
- Medicinal plants are good sources of natural antioxidants, that can help the body to fight against oxidative stress.
- Medicinal plants and their bioactive compounds exhibited therapeutic potentials which may play a role in reducing oxidative stress-related health complications.
- The effective role of medicinal plants in curing or preventing some chronic diseases, such as diabetes, and neurodegenerative disorders, such as Alzheimer's disease, Parkinson's disease, high blood pressure, cardiac problems, ageing etc. have been well documented in the present article.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

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