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A Review on Herbal Antioxidants

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The present review is an attempt to highlight the various ethno botanical and traditional uses as well as phytochemical and pharmacological reports on *Mimusops elengi* to which commonly known as Bakul and Spanish cherry, belonging to Sapotaceae family. It is a large ornamental evergreen tree cultivated in India and generally reared in gardens for the sake of its fragrant flowers. In the traditional Indian system of medicine, the ayurveda and in various folk system of medicine, the bark, fruit and seeds of *Mimusops elengi* possess several medicinal properties such as astringent, tonic, and febrifuge. Chemical studies have shown that, Bark contain tannin, some caoutchouc, wax, starch and ash and Flower contain volatile oil as well as Seeds contain fixed fatty oil. Preclinical studies have shown that *Mimusops elengi* or some part of its phytochemicals possess Analgesic, Antibiotic, Antihyperlipidemic, Anti-inflammatory, Antimicrobial, Antoxidant, Antipyretic, Cytotoxic, Congestive enhancing, Gingival bleeding, Gastic ulcer, Hypotensive activity.

Keyword: Mimusops elengi, Ethnobotany, Phytochemistry, Triterpenoids, Saponins

1. Introduction

As antioxidant is a molecule capable of slowing or preventing the oxidation of other molecules. Oxidation is a chemical reaction that transfers electron from a substance to an oxidizing agent. Oxidation reactions can produce free radicals, which start chain reactions that damage cells.

Antioxidants terminate these chain reactions by removing free radicals intermediates, and inhibit other oxidation agents such as thiols, ascorbic acid or polyphenols[1]. Although oxidation reactions are crucial for life, they can also be damaging; hence, plants and animals maintain complex systems of multiple types of antioxidants, such as glutathione, vitamin C, and vitamin E as well as enzymes such as catalase, superoxide dismutase and various peroxidase. Low levels of antioxidants, or inhibition, or inhibition of the antioxidants enzymes, cause oxidative stress and may damage or kill cells. As oxidative stress might be an important part of many human diseases, the use of antioxidants in pharmacology is intensively studied, particularly as treatments for stroke and neurodegenerative diseases. However, it is unknown whether oxidative stress is the cause or the consequence of disease[2].

In general, the reactive oxygen species circulating in the body tend to react with the electron of other molecules in the body and these also effect various enzyme systems and cause damage which may further contribute to conditions such as cancer, ischemia, aging, adult respiratory distress syndromes, rheumatoid arthritis etc[3]. The exogenous sources of ROS include electromagnetic radiation, cosmic radiation, UV-light, ozone, cigarette smoke and low wavelength electromagnetic radiations and endogenous

sources are mitochondrial electron transport chain, β-oxidation of fat. Chemical compounds and reaction capable of generating potential toxic oxygen species / free radicals are referred to as 'pro-oxidants'. They attack macromolecules including protein, DNA and lipid causing to cellular / tissue damage on the other hand, compounds and reactions disposing off these species, scavenging them suppressing their formation or opposing their actions are called antioxidants.

In a normal cell there is an appropriate pro-oxidant: antioxidant balance. However, this balance can be shifted towards the pro-oxidant when production of oxygen species is increased or when levels of antioxidants are diminished. This state is called 'oxidative stress' and can result in serious cell damage if the stress is massive or prolonge[4].

1.1 Classification of anti-oxidants:- It is of two types

1. Based on solubility:

(a) Hydrophilic antioxidants:- They are soluble in water. Water soluble antioxidants react with oxidants react with oxidants in the cell cytoplasm and blood plasma.

(b) Hydrophobic antioxidants:- They are soluble in lipids. Lipid soluble antioxidants protect cell membranes from lipid peroxidation.

2. Based on line of defense:

(a). First line defense (preventive antioxidant):-

These are enzymes like superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GTX), glutathione reductase and some minerals like Se, Mn, Cu etc. SOD mainly acts by quenching of superoxide (O_2), catalase by catalyzing the decomposition of hydrogen peroxide (H_2O_2) to water and oxygen. GTX catalyses the reduction of H_2O_2 and lipid peroxide generated during lipid peroxidation to water using reduced glutathione as substrate.

(b). Second line defense (Radical scavenging antioxidant):-

These are glutathione, Vit. C, uric acid, albumin, bilirubin, vit. E, carotenoids, flavonoid etc. β-carotene is an excellent scavenger of singlet oxygen. Vit. C interacts directly with radicals like O_2, OH. GSH is a good scavenger of many free radicals like O_2, OH and various lipid hydroperoxides and may help to detoxify many inhaled oxidizing air pollutants like ozone.

(c). Third line defense (Repair and de-novo enzymes):-These are a complex group of enzymes for repair of damaged DNA, protein, oxidized lipids and peroxides and also to stop chain propagation of peroxyl lipid radical. These enzymes repair the damage to biomolecules and reconstitute the damaged cell membrane.(4)

This includes study of following drugs:-

1. *Luffa cylindrica*

Family- Cucurbitaceae

Luffa cylindrical

Evaluated the *in vitro* antioxidant activity of fixed oil isolated from seed of *L. cylindrica*. 1-Diphenyl-2-picryl-hydrazyl (DPPH) radical, nitric oxide radical, hydroxyl and peroxide radical scavenging assay were carried out to evaluate the antioxidant potential of the fixed oil[5].

2. *Benincasa hispida*

Family- Cucurbitaceae

Benincasa hispida

The crude extracts of *Benincasa hispida* i.e. Methanolic extract (M.E.) and aqueous extract (A.E.) were studied for the presence and detection of phytochemical such as alkaloids, saponins, steroids, carbohydrates and flavonoids using standard procedures. On the basis of the results, the extracts were further used for *in vitro* evaluation of antioxidant activity. The present study was designed to study the phytochemical screening and to investigate the free radical scavenging potential of aqueous and methanolic extract of dried ripe peels of *Benincasa hispida*. The free radical scavenging potential was evaluated by DPPH 1.1,-diphenyl-2-picryl-hydrazyl)[6].

3. Sonchus asper

Family - Asteraceae

Sonchus asper

Evaluation of phenolic contents and antioxidant activity of various solvent extracts of *Sonchus asper* (L.) Hill. The SA extracts presented a remarkable capacity to scavenge all the tested reactive species with IC_{50} values being found at the µg/ml level. The SAME was shown to have the highest TPCs while lowest IC_{50} values for the DPPH• , ABTS •+ radical scavenging capacities and iron chelating scavenging efficiency, moreover, SAME had best activities in scavenging of superoxide radicals and hydrogen peroxide as well as potently scavenged the hydroxyl radicals. These results suggest the potential of S. asper as a medicine against free-radical-associated oxidative damage[7].

4. *Moringa oleifera*

Family - Moringaceae

Moringa oleifera

To assess the phytochemical constituents, total phenolic content, cytotoxicity and *in-vitro* antioxidant activity of stem bark extracts of *Moringa oleifera* (*M. oleifera)* (Moringaceae). Brine shrimp lethality (BSL) bioassay was used to investigate the cytotoxic effects. DPPH and nitric oxide radical scavenging activity was used to demonstrate antioxidant activity[8].

5. Cocculus hirsutus

Family – Menispermaceae

Cocculus hirsutus

In a step in this direction we have evaluated antioxidant potency of the ethanol extract on the aerial parts of *Cocculus hirsutus* Diels. The extract was investigated for its free radical scavenging action to wards 1, 1-Diphenyl–2picryl hydrazyl, nitric oxide, superoxide and hydroxyl radicals and found that the ethanol extract shows promising free radical scavenging activity in dose dependent manner. This antioxidant potency may be related to the presence of antioxidant vitamins and phenolic compounds present in the extract. These results clearly indicate that *Cocculus hirsutus* Diels is effective against free radical mediated diseases [9].

6. *Momordica charantia*

Family - Cucurbitaceae

Momordica charantia

The aim of the present study was to investigate the *in vitro* antioxidant activity of aqueous and methanol extracts of *Momordica charantia* leaves. The antioxidant activity of the plant extract was also determined by DPPH and ABTS methods using ascorbic acid and gallic acid as standards respectively[10].

7. *Prosopis cineraria*

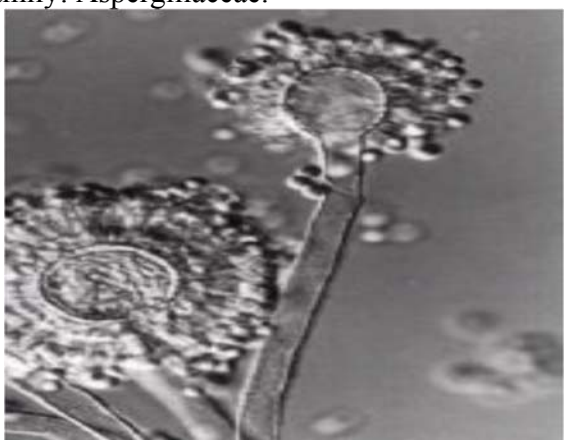
Family- Fabaceae

Prosopis cineraria

To evaluate antioxidant activity of different solvent fractions obtained from the leaves of *Prosopis cineraria*. Scavenging ability of the extracts for radicals like DPPH, ABTS, hydroxyl, superoxide, nitric oxide and hydrogen peroxide were performed to determine the potential of the extracts. All six fractions showed to have scavenging activity. The ethyl acetate and methanolic extracts showed to have maximum scavenging activity [11].

8. *Aspergillus candidus*

Family: Aspergillaceae.



Aspergillus candidus

Aspergillus candidus broth filtrate, extract was studied using different antioxidant models. It's ethyl extract scavenge the stable radical diphenyl picryl hydrazyl (DPPH) and radical cation 2,2-azinobis-(3-ethylbenzothiazoline-6- sulphonate) and thus, it shows antioxidant property due to presence of phenolic compounds[12].

9. Quercetin

Quercetin

It belongs to an extensive class of poly phenolic flavonoid compounds. *In vitro* antioxidant activity was tested for DPPH free radical, superoxide anions, hydrogen peroxide and hydroxyl radical. It scavenges oxygen radicals, inhibits xanthine oxidase, protects against lipid peroxidation, chelates metal ions and forms inert complexes that can't take part in the conversion of superoxide radicals and hydrogen peroxide into hydroxyl radicals[13].

10. ***Sphaeranthus indicus* Linn.** It is popularly known as 'Gorakhmundi'
Family: Asteraceae.

***Sphaeranthus indicus* Linn**

The ethanolic extract scavenges radical cation, DPPH, SOD and NO. Constituents are flavonoids, carbohydrates, alkaloids, gums and mucilage[14].

11. ***Rhizophora mangle*** bark
Family: Rhizophoraceae.

Rhizophora mangle

Deoxyribose assay was used. The total extract and its fraction showed scavenging activity of hydroxyl radicals and ability to chelate iron ions. Chemical constituents are polyphenols, carbohydrates, fatty acids and sterols[15].

12. ***Punica granatum*** fruits
Family: Punicaceae

Punica granatum

A ctivity was evaluated using DPPH test, 5-lipoxygenase assay and luminal / xanthine oxidase system (Chemiluminescence assay). Chemical constituents are tannins, alkaloids, glycosides[16].

13. ***Origanum dictamnus***
Family: Labiatae.

Origanum dictamnus

The aqueous extract scavenges free radicals generated by the fenton reaction and reducing oxygen consumption of a methyl linoleate emulsion. The active components of herb are phenolic compounds, mainly flavonoids and phenolic acids[17].

14. ***Rhus oxyacantha*** root cortex
Family: Anacardiaceae.

Rhus oxyacantha

Antioxidant activity has been examined ascorbic acid oxidation and inhibition of toxicity induced by an organochlorine pesticide, dichloro diphenyltrichloro ethane (DDT) in rat thymocytes. Chemical constituents are (+) epicatechin-3-0- gallate and proanthocyanidins oligomers and polymers. (+) and (-) epicatechin show hydroxyl radical scavenging activity and proanthocyanidins are efficient free radical scavenger. [18]

15. ***Diospyros malabarica kostel*** bark
It is popular as "Gab or Tinduk",
Family: - Ebenaceae.

Diospyros malabarica kostel

Different *in vitro*, like DPPH, nitric acid, superoxide, hydroxyl radical and lipid peroxide radical model were used in the study. Oxygen reacts with the excess nitric oxide to generate nitrite and peroxynitrite anions, which act as free radicals. The extract competes with oxygen to react with nitric oxide and thus, inhibits the generation of anions. Chemical constituents are phenolic compounds. Its stem bark is used for the treatment of intermittent fever and fruit juices for healing of wound ulcer. [19]

16. ***Asparagus racemosus***
Family: - Liliaceae.

Asparagus racemosus

It shows antioxidant activity through the free radical scavenging, superoxide anion radical scavenging, hydrogen peroxide scavenging, nitric oxide scavenging, metal chelation, reduction power and inhibition of lipid peroxidation in rats. Its chemical constituents are saponins (Shatavarin I-V), alkaloids, polyphenols, flavonoids, Vit. C. [20]

17. ***Glycyrrhiza glabra*** It is popular as licorice 'yashtimadhu'.
Family: - Leguminosae.

Glycyrrhiza glabra

Its extract was tested by studying the inhibition of radiation induced lipid peroxidation in rat liver microsomes. Chemical constituents are glycyrrhizin, flavones, coumarins. It shows its activity through free radical scavenging property. Its other actions are diuretic, demulcent, tonic etc.[21]

18. ***Boerhavia diffusa*** leaves
Family: - Nyctaginaceae.

Boerhavia diffusa

Alloxan induced diabetic rats were used in the study. Chemical constituents are rich in alkaloids and sterols including ursolic acid, hypoxanthine 9- L arabinofuranoside, punarnavine 1 and 2, myricyl alcohol and myristic acid. It decreases the level of thiobarbituric acid reactive substances (TBARS) and increases the activity of glutathione peroxidase (GPX) and glutathione-S- transferase (GST).[22]

19. ***Auricularia auricula*** It is popular as 'tree ear or wood ear'.
Family: - Auriculaceae.

Auricularia auricular

It has potent hydroxyl radical scavenging and lipid peroxidation inhibition activities. Chemical constituents are flavonoids. [23]

20. ***Annona squamosa*** It is popular as 'Custard apple or Sitaphal'.
Family: - Annonaceae.

Annona squamosal

Streptozotocin induced diabetic rats were used. It reduces the lipid peroxidation and increases the activity of antioxidant enzymes and strong super oxide radicals and singlet oxygen quenchers. Chemical constituents are flavonoids.[24]

21. ***Echium amoenum*** **Fisch** and C.A. Mey Flower. Family: - Annonaceae.

Echium amoenum **Fisch**

Chemical constituents are rosmarinic acid and flavonoids. Flavonoids highly scavenge most types of oxidizing molecules including singlet oxygen and various free radicals and rosmarinic acid scavenge superoxide and hydroxyl radicals.[25]

22. ***Eucalyptus globules*** It is popular as "Karpura maram".
Family: - Myrtaceae.

Eucalyptus globules

The antioxidant activity of eucalyptus oil was estimated by two *in vitro* assays namely diphenyl picryl hydrazyl radical scavenging activity and inhibition of Fe-ADP-ascorbate induced lipid peroxidation method. [26]

23. **Pepticare:** - It is a herbomineral formulation it was administered orally to rats to investigate its effect on isoproterenol induced myocardial infraction and cisplatin induced renal damage. It increases the levels of SOD, CAT and reduces GSH membrane bound enzymes like Ca^{2+}, Mg^{2+} and $Na^{+}K^{+}$ ATPase and decreases lipid peroxidation (MDA) in heart and kidney. Thus, it protects the heart and kidney from damage caused by isoproterenol and cisplatin.[27]

24. ***Acacia arabica*** bark
Family: - Mimosae.

Acacia arabica

There are *in vivo* and *in vitro* experimental models. *In vitro*, lipid peroxidation was carried out by tertiary butyl hydroperoxide (TBH) induced lipid peroxidation. *In vivo*, experiments were carried out in CCl_4-induced hepatotoxicity in rats. The bark contains (+) catechin, (-) epicatechin, quercetin and gallic acid. The polyphenol rich active fraction pf *Acacia arabica* is a potent free radical scavenger and protects TBH induced lipid peroxidation and CCl_4-induced hepatic damage. It is used in the treatment of asthma, bronchitis, diabetes, dysentery and skin diseases.[28]

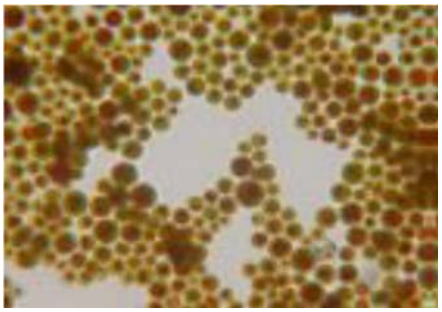
25. **Arthritin (Polyherbal formulation):-**
It consisting of extracts of *Acacia Arabica*, *Withania somnifera*, *Juniperus communis*, *Asparagus racemosus*, *Tinospora cordifolia*, *Tribulus terrestris*, *Anethum sowa*, *Curcuma zerumbet* and *Zingiber officinale*. Phenols, flavonoids, terpenoids, alkaloids, glycosides are present in the various constituents of the polyherbal formulation act as natural free radical scavengers. It causes decreases in serum lipid peroxidase and increase in SOD & GTX. It possess a significant anti-inflammatory and free radical scavenging activity and also responsible for antiarthritic activity.[29]

26. ***Acacia catechu*** It is popular as 'Khadira' (black catechu).
Family: - Leguminosae.

Acacia catechu

Its extract was tested by studying the inhibition of radiation induced lipid peroxidation in rat liver microsomes. Its chemical constituents are catechin, tannic acid, quercetin, red tannin. It's a powerful astringent.[30]

27. **Astaxanthin** It is the member of the carotenoid family. It is obtained from *haematococcus pluvialis.* It can serve as a potent free radical



Astaxanthin

It provides many essential biological functions, including protection against lipid membrane peroxidation of essential polyunsaturated fatty acids and proteins, DNA damage and UV light effects. It also plays an important role in immunological defense[31].

28. ***Ligustrum vulgare*** **and** ***L. delavayanum*** leaves
Family: - Oleaceae.

Ligustrum vulgare ***L. delavayanum***

Activity was evaluated using DPPH test. Its chemical constituents are flavonoids, iridoids, coumarins, phenyl propanes and essential oil. Flavonoid aglycones are responsible for the activity. It shows free radical scavenging activity[32].

29. **Triphala:**

Triphala

It is a traditional ayurvedic herbal formulation consisting of the dried fruits of three medicinal plants. *Terminalia chebula, Terminalia belerica* and *Phyllanthus emblica,* also called as 'three myrobalans'. Activity was evaluated using DPPH test[33].

30. ***Terminalia chebula*** It is known as '*Myrobalanus chebula* or Harde'.
Family: - Combretaceae.

Terminalia chebula

Its chemical constituents are tannins, chebulinic, ellegic and gallic acids. Its extract was tested by studying the inhibition of radiation induced lipid peroxidation in rat liver microsomes. It shows free radical scavenging activity due to presence of tannins. It inhibits the development of duodenal ulcer and appeared to extract a cytoprotective effect on the gastric mucosa[34].

31. ***Phyllanthus emblica*** It is known as '*Emblica officinalis* or Amla.
Family: - Euphorbiaceae.

Phyllanthus emblica

Its chemical constituents are tannins and other phenolic compounds and flavonoid quercetin. It is a rich source of Vit. C. It interacts directly with radicals and scavenges them and hence, shows

antioxidants activity. It is used for the treatment of common cold, scurvy, cancer and heart disease[35].

32. *Lobelia nicotianaefolia*

Family: - Campanulaceae.

Lobelia nicotianaefolia

Its chemical constituents are alkaloids important of them are lobeline. Also contains volatile oil, resin, gum and fixed oil. It is mainly used in the treatment of asthma and as respiratory stimulant.[36]

33. ***Arnica Montana* Linn** - It is commonly called as 'Arnica'.
Family: - Compositae.

***Arnica montanas* Linn**

Its chemical constituents are volatile oil, flavonoids and terpenoids, sesquiterpene lactones from helenanolide group like helenalin and other ester derivatives reported to possess antioxidant, antihyperlipidemic and antitumor activity. It shows free radical scavenging activity due to presence of flavonoids[37].

34. ***Zingiber officinale***: It is commonly called as 'ginger'.
Family: - Zingiberaceae.

Zingiber officinale

Its chemical constituents are volatile oil, starch, acrid resinous matter, shagoals, zingerone, peradols etc.

35. *Rosmarinus officinalis*

Family: - Labiatae.

Rosmarinus officinalis

The flowers contain volatile oil (rosemary oil), resin and ursolic acid. Volatile oil contains mainly borneol. It is also used as a spice in tea to help ward off cancers, heart diseases etc. Antioxidant activity is due to borneol.

36. *Mentha arvensis*

Family: - Labiatae.

Mentha arvensis

The antioxidant activity of menthe oil was estimated by two *in vitro* assays, DPPH radical scavenging activity and inhibition of Fe-

ADPAscorbate induced lipid peroxidation (LPO) method. It contains 80% L-menthol and due to this, it shows antioxidant property. It shows antioxidant activity by decreasing lipid peroxidation.

37. *Citrus lemon*

Family: - Rutaceae.

Citrus lemon

The antioxidant activity was estimated by two *in vitro* assays, DPPH radical scavenging activity and inhibition of Fe-ADP-Ascorbate induced lipid peroxidation (LPO) method. It contains mainly citral and limonene. The antioxidant property is shown due to presence of citral.

38. *Decalepis hamiltonii*

Family: - Asclapiadaceae.

Decalepis hamiltonii

Various model systems like DPPH, β-carotene linoleate and hydroxyl radical scavenging activity were used in the study. This is act by easing the level of endogenous defenses by upregulating the expression of genes encoding the enzymes such as superoxide dismutase (SOD), catalase (CAT) or glutathione peroxidase (GTX). The main constituent by which activity is shown is 2-hydroxyl-4-methoxy benzaldehyde[38].\

3. Conclusion

Oxidative stress has been implicated in the pathology of many diseases and condition including diabetes, cardiovascular diseases, inflammatory conditions, cancer and aging. Antioxidant may offer resistance against the oxidative stress by scavenging free radicals, inhibiting lipid peroxidation and by many other mechanisms and thus prevent disease, and today widely used as free radicals inhibitors in food for maintaining the freshness, flavor and odor for a longer period.

Current research reveals the different potential application of antioxidant/free radical manipulations in prevention or control of diseases. Natural products from dietary components such as Indian species and medicinal plants are known to possess antioxidant activity. Future approach include gene therapy to produce more antioxidant in the body, genetically engineered plant products with higher level of antioxidant, synthetic antioxidant enzymes (SOD mimics), novel biomolecules and the use of functional foods enriched with antioxidant.

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