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Antioxidant Properties of Plant Extracts

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Abstract

There is a continued interest to screen plant extracts for their antioxidant properties, in light of the fact that antioxidant activities parallel anticancer activities, amongst their ability to combat other diseases. Cancer is one of the diseases that has a high mortality status in developed countries and is on the rise in developing countries. Plant extracts have been tested for their antimicrobial, anticancer, Antidiabetic, insect repellant and a range of other biological activities. Since 1990s, antioxidant research has expanded significantly, due to its potential benefits in disease prevention and health promotion. Guyana, a country located on the mainland of South America and whose rich diverse flora needs continual screening for plants with a range of pharmaceutical and medicinal activities of which, antioxidant is one. In addition, the isolation of known and unknown natural antioxidants may contribute to novel drug discovery. This article is a mini review of plants/plant extracts that have exhibited antioxidant properties.

Keywords: Screen plant extracts, Antioxidant activities, Anticancer activities, Antidiabetic activities.

Introduction

Antioxidants are chemical compounds or mixture of compounds, which when present in low concentrations are used to prevent the oxidation of lipids, sugars and proteins and DNA that can generate aldehydes, ketones, esters and other products that can be harmful to living systems. Antioxidants can be synthetic or natural. Synthetic antioxidants include Butylated Hydroxyl Anisole (BHA), Butylated Hydroxyl Toluene (BHT), Tert-Butyl Hydroquinone (TBHQ) and Propyl Gallate (PG) etc [1]. Natural antioxidants are those that can be obtained from fruits, vegetables and plant extracts. There is an increasing interest to use plant extracts as antioxidant agents.

Table 1 shows some plants that have rich antioxidant profile, whereas **Table 2** shows the chemical constituents of some antioxidant plants. Natural antioxidants may function (a) as reducing agents, (b) as free radical scavengers, (c) as complexers of pro-oxidant metals, and (d) as quenchers of the formation of singlet oxygen. However, the major value is in their primary antioxidant activity as free radical acceptors and as chain breakers. Free radicals are usually produced in normal or pathological cell metabolism. Reactive Oxygen Species (ROS) react with free radicals to become free radicals themselves. ROS include free radicals such as superoxide anion radicals, hydroxyl radicals, non-free radical species and singlet oxygen [2-5].

Excess generation of ROS, induced by various stimuli and which exceed the antioxidant capacity of the organism can lead to various pathophysiological processes such as diabetes, cancer, inflammation, genotoxicity, alzheimers disease and cataracts, retinopathy, rheumatism, skin disease porphyria and senile dementia stroke [6-8]. Antioxidants usually react with reactive free radicals to destroy them by accepting or donating electron(s) to eliminate the radical or they may indirectly decrease the formation of free radicals. Antioxidants also act by forming complexes with metals.

Human cells protect themselves against enzymatic and non-enzymatic antioxidant systems against free radical damage. However, these protective antioxidant mechanisms may not be enough to prevent severe or continued antioxidant stress [9]. Hence, natural or synthetic antioxidants are necessary. In nature, there is a wide variety of natural antioxidants which are different in their chemical composition, physical and chemical properties.

These include enzymes such as Superoxide dismutase, catalase etc. High molecular weight compounds such as protein like albumin, transferrin, ceruplasmin, low molecular weight compounds such as tocopherol, quinines, bilirubin, ascorbic acid, uric acid etc. Minerals such as selenium, copper, manganese, zinc etc. Vitamins such as vitamin A, C and E and plant antioxidants. Also the flavonoids (flavanols, isoflavones, flavones, catchins, flavanones), cinnamic acid derivatives, coumarins, tocopherols, and polyfunctional organic acids. Some of these are shown in **Figure 1** Screening of plants for antioxidant activities can be established via various *in vitro* methods such as DPPH, Nitric oxide method, DMPD, ABTS, ORAC, TBARS assays [1-8], [20-25] etc.

Guyana has a richly biodiversified flora and medicinal studies such as antimicrobial [10-18], antidiabetic [19] have received increasing attention. However, there are few unpublished work on antioxidant and anticancer activities. It's highly imperative that research proliferate with regards to anticancer and antioxidant activities as there are an alarming increase in the deadly cancer disease worldwide and in Guyana. Plant parts such as stems, leaves and fruits rich in antioxidant properties are good in combat against cancer. Also, the chromatographic purification of the crude plant extracts from the Guyanese flora can lead to known and unknown natural products, whose antioxidants properties can be investigated and compared with the crude plant extracts. This forms the basis for novel antioxidant drugs discovery.

Few researches in Guyana have done on the isolation of natural products from plants of the Guyanese flora. The isolation of natural products from *Montricardia arborescens and Passiflora edulis*, two plants from the Guyanese flora, suspected to have antioxidant properties has been pursued. **Table 3** shows some plants with suspected antioxidant properties, based on folklore from the flora of Guyana. There chemical constituents needs investigation.

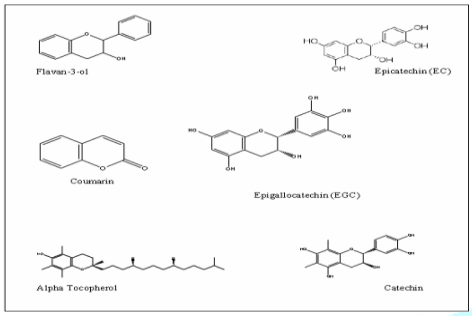


Figure 1: Some antioxidants isolated from plants.

	Name of Plants	Family	Part used
1	*Allium sativum Linn*	Lilaceae	Bulb
2	*Asparagus racemosus Willd*	Lilaceae	shoot
3	*Baccharis cordifolia DC*	Asteraceae	Aerial parts
4	*Bryonia alba Linn*	Cucurbitaceae	Root
5	*Cichorium intybus Linn*	Asteraceae	leaf
6	*Cinnamomum zeylanicum Breyn*	Lauraceae	Bark
7	*Crithmum maritimum Linn*	Apiaceae	Essential Oil
8	*Cynara scolymus Linn*	Asteraceae	Leaf
9	*Emilia sonchifolia DC*	Asteraceae	leaf
10	*Eucalyptus camaldulensis Dehnh. syn*	Myrtaceae	leaf
11	*Eucommia ulmoides Oliver*	Eucommiaceae	leaf
12	*Garcinia kola Heckel*	Clusiaceae	fruit
13	*Ginkgo biloba Linn*	Ginkgoaceae	leaf
14	*Lavandula angustifolia Mill*	Lamiaceae	Aerial parts
15	*Lycium barbarum Linn*	Solanaceae	Fruit
16	*Melissa officinalis Linn*	Lamiaceae	Aerial parts
17	*Murraya koenigii (Linn) Spreng.*	Rutaceae	leaf
18	*Myrica gale Linn*	Myricaceae	Fruit
19	*Panax ginseng Mey*	Araliaceae	Root
20	*Picrorrhiza kurroa Royle ex Benth*	Scrophulariaceae	Rhizome, Root
21	*Piper nigrum Linn*	Piperaceae	Fruit
22	*Plantago asiatica Linn*	Plantaginaceae	seed
23	*Prunus domestica Linn*	Rosaceae	Fruit
24	*Rhazya stricta Decne*	Apocyanaceae	leaf
25	*Rosmarinus officinalis Linn*	Lamiaceae	Aerial parts
26	*Salvia officinalis Linn*	Lamiaceae	Aerial parts
27	*Salvia triloba Linn. F.*	Lamiaceae	leaf
28	*Solanum melongena Linn*	Solanaceae	Fruit
29	*Solanum tuberosum Linn*	Solanaceae	Tuber
30	*Syzygium caryophyllatum* (Linn)	Myrtaceae	Flower buds
31	*Thymus zygis Sibth & Sm*	Lamiaceae	Aerial parts
32	*Tinospora cordifolia* (Willd)	Menispermaceae	Root
33	*Uncaria tomentosa DC.*	Rubiaceae	Bark
34	*Zingiber officinale Rosc.*	Zingiberaceae	Rhizome

Table 1: Some medicinal plants with antioxidants activity.

The antioxidant activities of plant extracts, fruits and vegetables are well documented [1-9], [20-25]. Thirty (30) plants aqueous extracts were investigated for their antioxidant properties via several methods such as DPPH, ABTS radical scavenging capacity assay, Oxygen Radical Absorbance Capacity (ORAC) assay, Superoxide Dismutase (SOD) assay, and Ferric Reducing Antioxidant Potential (FRAP) [20]. In addition, the Total phenolic content was determined by the Folin−Ciocalteu Method, (FCM). Results showed that oak (*Quercus robur*), pine (*Pinus maritima*), and cinnamon (*Cinnamomum zeylanicum*) aqueous extracts possessed the highest antioxidant activities and thus could be potential rich sources of natural antioxidants. A significant relationship existed between antioxidant capacity and total phenolic content, indicating that phenolic compounds are the major contributors to the antioxidant properties of these plants [20].

The antioxidant activities of the methanol extracts from the leaves and stems of *Celtis africana* (Ulmaceae) were assessed in an effort to validate the medicinal potential of the subterranean part of the herb. The antioxidant activity and phenolic contents of the stem as determined by the DPPH, proanthocyanidins, total phenols, the flavonoids, and total flavonols were higher than that of the leaves [21].

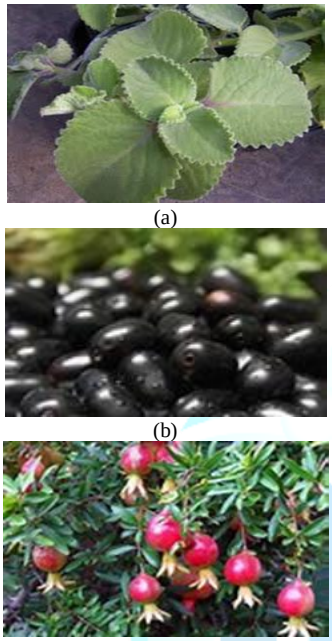
	Botanical/ Family	Common name	Part used	Chemical constituents
1	*Curcuma domestica Valeton syn.*	Turmeric	leaf	Curcumin, b-pinene, Camphene, eugenol, b-sitosterol
2	*Cuscuta reflexa Roxb.* (Convolvulaceae)	Akashabela	Stem	Flavonoids, dulcitol,Bergenin, coumarins, Glycosides, lactone
3	*Daucus carota*	Carrot	Root	Carotenes, carotenoids, glycosides, flavonoids, sugars, quaternary bases
4	*Emblica officinalis Gaertn* (Euphorbiaceae)	Amla/Emblic Myrobalan	Fruit	Vitamin C (L-ascorbic acid), polyphenols (ellagic acid, gallic acid, tannins)
5	*Foeniculum vulgare Mill*	Saunf, Fennel	Fruit oil	
6	*Glycyrrhiza glabra Linn* (Fabaceae)	Mulethi Liquorice	Root	Glycosides
7	*Mangifera indica Linn* (Anacardiaceae)	Am/Mango	Root. Leaf, fruit	Cyanogenetic glycosides, Polyphenols, vitamin A & C, mangiferein, b-sitosterol, quercetin, ellagic acid, gallic acid
8	*Momordica charantia Linn* (Cucurbitaceae)	Karela/Bitter Melon	Root, leaf, fruit, seed	Stearic acid, triterpene, glycosides
9	*Ocimum sanctum Linn* (Lamiaceae)	Tulsi/Sacred Basil	leaf	Volatile oil, terpenoids, eugenol, thymol, estragole
10	*Psoralea corylifolia Linn.* (Fabaceae)	Babchi	seed	Essential oil, fixed oil, resin, bakuchiol (monoterpene phenol)
11	*Santalum album Linn* (Santalaceae)	Safed chandan/Sandal	Heartwood , Bark	Volatile oil,Santalol,-santalol, b-santalol, b-sitosterol
12	*Solanum nigrum Linn. Solanaceae*	Makoi/Commo n Nightshade	Leaf	Polyphenolic compounds, Flavonoids, Steroids
13	*Swertia chirayita*	Chirayita/ Chiretta	Whole plant	Xanthones, mangiferin, swertinin, chiratin, arginine

Table 2: Antioxidant plant and chemical constituents.

	Botanical/Family name	Common name	Part used
1	*Abrus precatorious* (Leguminosae)	Crab eyes	Leaf and bark
2	*Curcuma domestica Valeton syn.*	Turmeric	leaf
3	*Annona muricata* (Annonaceae)	Kaiedi Soursop	Leaf and fruit
4	*Artocarpus altilis* (Moraceae)	Breadfruit	Leaves and fruit
5	*Cuscuta reflexa Roxb.* (Convolvulaceae)	Akashabela	Stem
6	*Daucus carota*	Carrot	Root
7	*Emblica officinalis Gaertn* (Euphorbiaceae)	Amla/Emblic Myrobalan	Fruit
8	*Foeniculum vulgare Mill*	Saunf, Fennel	Fruit oil
9	*Syzygium cumini*	Jamun	leaf and fruit
10	*Mangifera indica Linn* (Anacardiaceae)	Am/Mango	root. Leaf, fruit
11	*Momordica charantia Linn* (Cucurbitaceae)	Karela/Bitter Melon	root, leaf, fruit, seed
12	*Ocimum sanctum Linn* (Lamiaceae)	Tulsi/Sacred Basil	leaf
13	*Passiflora edulis*	Passion fruit	fruit
14	*pomegranate*	(Punica granatum)	fruit
15	*Solanum nigrum Linn. Solanaceae*	Makoi/Common Nightshade	leaf
16	*Broad leaf Thyme*	Plectranthus amboinicus	leaf
17	*Rumex acetosa*	Sorrel	fruit
18	*Morinda citrifolia*	Yaw-weed	leaves

Table 3: Some Antioxidant plants found in Guyana.

Three plant foods, namely, drumstick leaves (*Moringa oleifera*), mint leaves (*Mentha spicata*) and carrot tuber (*Daucus carota*) ethanolic extracts were analyzed for their antioxidant activity. The antioxidant activity of extracts was evaluated according to the amount of Malonaldehyde (MDA) formed by the $FeSO_4$-induced oxidation of linoleic acid and a high PUFA oil (sunflower oil) at 37 °C in Trizma-buffer (pH 7.4). The antioxidant activity of the extracts from mint leaves and carrot was higher at pH 9 than pH 4, while that of drumstick extract remained the same under both pH conditions [22].



(a) (b) (c)

Figure 2: Pictures of some plant parts from antioxidant plants from the Guyanese flora. (a) Thyme (b) Jamoon (c) Pomergranate.

The antioxidative activity of 92 phenolic extracts from edible and nonedible plant (berries, fruits, vegetables, herbs, cereals, tree materials, plant sprouts, and seeds) was examined by autoxidation of methyl linoleate method [23]. The total phenolic content in the extracts was determined spectroscopically via the Folin−Ciocalteu assay. For the edible plants, high antioxidant activity and high total phenolic content, expressed as Gallic acid equivalents, were found in berries (GAE > 20mg/g), such as aronia and crowberry. Apple extracts (two varieties) also showed strong antioxidant activity, despite low total phenolic contents (GAE < 12.1 mg/g).

For nonedible plant species, high antioxidant activities were found in willow bark, spruce needles, pine bark, cork, and birch phloem, and in some medicinal plants such as heather, bog-rosemary, willow herb, and meadowsweet. Potato peel and beetroot peel extracts also showed strong antioxidant effects [23]. Natural antioxidants from plants can protect against DNA oxidative damage human lymphocytes induced by hydrogen peroxide, H_2O_2. Thus, six herbaceous plants, including *Bidens alba* (BA), *Lycium chinense* (LC), *Mentha arvensis* (MA), *Plantago asiatica* (PA), *Houttuynia cordata* (HC), *and Centella asiatica* (CA) were investigated for their antioxidant activities.

The plants were found to be rich in flavonols, such as myricetinin BA, morin in MA, quercetin in HC, and kaemperol in CA. In addition, polyphenol were abundant in BA and CA. Antioxidant efficacy was determined by the inhibition percentage of conjugated diene formation in a linoleic acid emulsion system and by Trolox-Equivalent Antioxidant Capacity (TEAC) assay.

The acidic methanolic extract of PA, induced the best conjugated diene formation inhibition percentage. For TEAC, the best antioxidant activity was generated from the acidic methanolic extract of HC [24].

Extracts from Brazilian plants, belonging to 16 species of 5 different families (71 extracts) were tested for their antioxidant activities. Ginkgo biloba and rutin, commonly used as antioxidants for medical purposes, were used as standards.

The ethanol extracts of plants belonging to the Verbenaceae family showed lower EC_{50} values than the other plant extracts. It was found that the more polar partitions (ethyl acetate and n-butanol) are those that generally have higher antioxidant activity [25].

Conclusion

Plant extracts, fruits and vegetables have indeed shown to possess antioxidant activities. Research needs to be continued for the search of plant with interesting antioxidant effects. In addition, the isolation of known and unknown natural antioxidants will form the platform for novel drug discovery. In this regards, diverse rainforest tropical flora in a diverse ecosystems from Guyana, needs further herbal exploration and commercialization, in addition to their impetus for eco-tourism. Only a couple of reports on the isolation of natural products from two plants suspected to have antioxidant properties have been reported here. Apart from antioxidant drugs, new drugs such as anti-AIDS, anti-cancer, anti-diabetes, anti-arthritis and anti-alzheimers still awaiting discovery.

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