eISSN 2330-0280

VEDIC RESEARCH INTERNATIONAL

PHYTOMEDICINE

JOURNAL HOME PAGE AT WWW.VEDICJOURNALS.COM

REVIEW

http://dx.doi.org/10.14259/pm.v1i1.23

Certain Traditional Indian Plants and Their Therapeutic Applications: A Review

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Article Info

Received: May 27th, 2013
Revised: June 13th, 2013
Accepted: June 15th, 2013

Keywords

Indian traditional medicinal plants,
Herbal ingredients,
Antioxidants,
Diseases,
Antimicrobial,
Anticancer

ABSTRACT

Plants have always been an exemplary source of drugs. Many of the currently available drugs have been derived directly or indirectly from herbal sources. Herbal medicines have proved to be highly effective, economical and safe alternative tools for treatment of various human diseases. The medicinal plants are known to contain several phytochemicals such as carotenoids, terpenoids, alkaloids, flavonoids, polyphenols, tannins, saponins, enzymes, proteins, minerals and vitamins etc. These phytochemicals possess antidiabetic, antioxidant, antimicrobial, anti-inflammatory and anticancer activities. Their traditional applications provide valuable clues for selection of plant products for development of drugs based on their active chemical ingredients. Several workers are currently involved in studying the medicinal properties of plants by isolating their active compounds by bioassay-guided fractionation from the species that showed high biological activity during screening. This paper presents a recent account of therapeutic potentials of certain phytochemicals isolated from five Indian medicinal plants such as *Azadirachta indica, Aloe vera, Aegle marmelos, Tinospora cordifolia* and *Momordica charantia,* which are reported to be highly effective against different diseases. All the parts of these plants have been reported to contain antidiabetic, antioxidant, antimicrobial, anticancer and anti-inflammatory principles. In addition, brief accounts of some other plants showing antioxidative and antidiabetic properties are also included. This article further emphasizes the need to conduct acute toxicity studies with the herbal ingredients so as to address safety issues prior to their administration in the subjects.

INTRODUCTION

India harbors the richest plant-based medical traditions in the world. According to an estimate, there are around 25,000 effective plant-based formulations used as folk medicine in curing many ailments and diseases. Many of such medicinal plants are known to rural communities in India and they frequently use varied herbal preparations as alternative medicines.

In ancient India, about 75% of the population was dependent on the traditional system of medicine known as Ayurveda. Currently, the traditional medicines are being used by about 60% of the world's population. In 2002, Chopra and Doiphode reported that ayurveda is the most ancient health care system and is practiced in India as well as in other countries [1]. Ayurvedic practitioners have identified a number of medicinal preparations and surgical procedures for curing various ailments and diseases. Even in this era of modern medicines, many drugs have come to the market from plant sources used by the indigenous communities [2].

The widespread use of herbal ingredients and healthcare preparations, as those described in ancient texts such as the Vedas and the Bible, and obtained from commonly used traditional herbs and medicinal plants, have traced the occurrence of natural products with medicinal properties. Plant spices and herbs provide means to enhance cuisine to gustatory perfection, while at the same time these condiments contain bioactive principles that help to prevent serious ailments such as hypertension and infection.

The World Health Organization (WHO) estimates that about 80% of the world's population relies mainly on herbal medicine for primary healthcare [3-4]. The use of traditional medicine and medicinal plants in most developing countries, as a normative basis for the maintenance of good health, has been widely observed [5].

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Out of a plethora of Indian medicinal plants, we have selected only five most important Indian medicinal plants such as *Azadirachta indica*, *Aloe vera*, *Aegle marmelos*, *Tinospora cordifolia* and *Momordica charantia*, which are commonly grown in many areas of India. The plants are known to contain certain chemical ingredients which are used for the treatment of number of diseases. Recently, the interest in medicinal plants has tremendously increased due to failure of modern medicines to provide effective treatment without any toxicity and side effects. Besides that, herbal drugs are cost effective too. With the onset of scientific research in natural products it is becoming clearer that medicinal plants have a potential in today's synthetic era. With the progress of new technologies, new avenues have been opened in purifying active components from the plants and establishing their chemical structures or even to synthesize and modify them chemically. So the ancient knowledge coupled with the modern scientific principles can come into the forefront and provide us with powerful remedies to several diseases.

Some Common Indian Medicinal Plants With phytochemical activities

1. Azadirachta indica

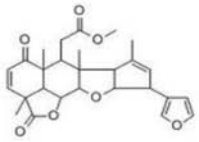
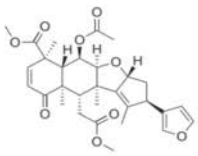
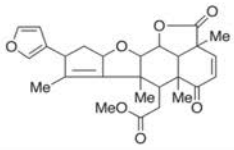
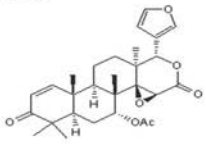
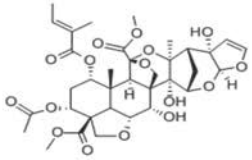
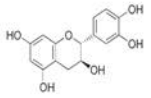
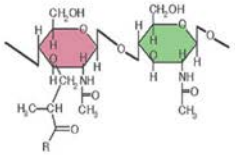
The *Azadirachta indica* is popularly known as Indian Neem or Indian lilac. It is an evergreen fast-growing tree belongs to family *Meliaceae*, cultivated in various parts of the Indian subcontinent and the dry forest areas of South and Southeast Asia including Pakistan, Sri Lanka, Thailand and Malaysia. They are also cultivated in most other countries of the world [6]. Neem tree has been extensively used in unani, ayurveda and homoeopathic systems of medicine.

The biological and pharmacological activities attributed to solvent extracts and products like oil from different parts of *A. indica* are as diverse as hepatoprotective [7], anti-inflammatory, antinociceptive and antipyretic [8], antidiabetic [9], antioxidant [10], anticancer [11], sperm mitochondrial [12], antimalarial [13] and immunomodulating agents [14]. Although a large number of compounds have been isolated from various parts of neem, a few of them have been used as traditional Ayurvedic medicine with phytochemical constituents as shown in Table 1.

The investigation of the chemical products isolated from neem tree was extensively undertaken in the middle of the twentieth century. Since the first report released by Siddiqui [15] on the isolation of the nimbin, the first bitter compound isolated from neem seed oil, more than 135 compounds have been isolated so far from different parts of this plant and characterized with respect to their biological activities reported as anti-inflammatory [16], antipyretic [17], Hypoglycaemic [18], antigastric ulcer [19], antifungal [20] and spermicidal [21].

Certian specific phytochemicals isolated from Neem contain immense therapeutic potential. For example Nimbolide isolated from Neem seed oil is anti-bacterial [22] and anti-malarial [13], gedumin isolated from Neem seed is antifungal [23] and anti-malarial [13], Azadirachtin isolated from Neem seed is anti-malarial [25], Catechin isolated from Neem bark is immunomodulatory [26] and certain polysaccharides isolated from Neem bark are anti-tumor [27] in nature (Table 1). The aqueous leaf extract when orally fed, produces hypoglycaemia in normal rats. It also decreases blood glucose level in experimentally-induced diabetic rats [28]. The chloroform extract of stem bark is effective against carrageenin-induced paw oedema in rat and ear inflammation in the mouse [29].

Table 1: Some bioactive compounds from Neem:

Neem compounds	Source	Biological activity	Reference
Nimbidin 	Seed oil	Hypoglycaemic, Antifungal Spermicidal Antigastric ulcer Anti-inflammatory	[18] [21] [21] [19] [16]
Nimbin 	Seed oil	Spermicidal	[21]
Nimbolide 	Seed oil	Antibacterial Antimalarial	[22] [13]
Gedumin 	Seed	Antifungal Antimalarial	[23] [24]
Azadirachtin 	Seed	Antimalarial	[25]
Catechin 	Bark	Immunomodulatory	[26]
Polysaccharides Gi_a, GII	Bark	Antitumor	[27]
NB-II peptidoglycan 	Bark	Immunomodulatory	[14]

Inflammatory stomatitis in children is cured by the bark extract [30]. Neem oil shows toxicity to fish like tilapia and carp, with an LC_{50} of 1124.6 and 302.7 ppm, respectively. Neem seed oil showed acute toxicity in rats and rabbits with LD_{50} of 14 ml/kg body weight and 24 ml/kg body weight, respectively; the possible target organs for toxic effects being the CNS and the lungs [31]. Anofi et al. [32] have reported the toxicity profile of ethanolic stem bark extract of *A. indica* in male Wistar rats. Their results showed that the doses such as 50, 100, 200 and 300 mg/kg body weight might not be completely safe as an oral remedy and should be taken with caution, if absolutely needed.

Mahdi group have reported significant increase in lipid peroxide levels in streptozotocin induced diabetic rats with respect to normal controls, which significantly decreased due to treatment with herbal preparations of *A. indica* [33]. The isolated compounds from *A. indica*, have shown impressive efficacy against a wide variety of human cancer cell lines, and also in animal models for human cancers that include colon, stomach, Ehrlich's carcinoma, lung, liver, skin, oral, prostrate, and breast cancers [34]. Chemical investigation of leaves of *A. indica* resulted in the isolation of quercetin and β-sitosterol [35]. Quercetin is a bioflavonoid with an antioxidant potential comparable to that of vitamin E [36]. β- sitosterol is a plant sterol having anti-inflammatory and immunomodulatory activities as reported by Bonic [37]. Yanpallewar group have estimated its hepatoprotective role. The fresh juice of leaves of *A. indica* (200 mg/kg b.w.) inhibited paracetamol (2 g/kg b.w.)-induced lipid peroxidation and prevented depletion of sulfhydryl groups in liver cells [38].

2. *Aloe vera*

In India, it is commonly known as Ghee Kunwar in Hindi and *Aloe vera* in English; also known as the Medicinal Aloe belonging to family *Liliaceae*. Type 2 Diabetes Mellitus is one of the primary threats to human health due to its increasing prevalence, chronic course and disabling complications. *A. vera* is widely distributed plant in tropical regions of the world. Many cosmetic and medicinal products are made from the mucilaginous tissues located in the centre of the *A. vera,* called as *Aloe vera* gel. Yongchaiyudha et al. [39] have estimated the potential use of *A. vera* as an anti-diabetic agent. Rajasekaran group have studied the oral administration of aqueous leaf extract of *A. vera* gel at a dose of 300 mg/kg body weight per day to STZ-induced diabetic rats for a period of 21 days. The results indicated a significant reduction in the levels of fasting blood glucose, hepatic transaminases (AST and ALT), plasma and tissue (liver) cholesterol, triglycerides, free fatty acids and phospholipids and a significant improvement in plasma insulin [40]. Plant derived natural products such as flavonoids, steroids and terpenoids etc. isolated from *A. vera* and other plants have received considerable attention in recent years due to their diverse pharmacological properties including antioxidant and anticancer activities [41-42]. According to the American Cancer Society, deaths arising from cancer constitute 2-3% of the annual deaths recorded worldwide [43]. The antitumor activity of 50% ethanol extract (100 mg/kg) of *A. vera* was evaluated against *Ehrlich ascites* carcinoma (EAC) tumor in mice by Naveena et al. [44]. The ethanolic extract of *A. vera* leaf skin was fractionated by liquid-liquid partition using hexane, ethyl acetate, chloroform-ethanol and butanol. The chloroform-ethanol fraction showed the highest total phenolics (40.500 ± 0.041 μg gallic acid equivalents/g of extract), the highest free radical scavenging activity and the greatest reducing power, followed by ethyl acetate, butanol and hexane extracts. However, the hexane fraction showed the highest antioxidant capacity (471.300 ± 0.013 μM Fe(II)/g) and the highest antioxidant activity coefficient (AAC) as determined by the β-carotene bleaching method [45].

Table 2: Medicinal properties of different extract of *Aloe vera*

Type of extract	Medicinal properties	Type of study	References
Pulp	Detoxification agent	*in vivo*	[47]
Pulp and liquid fraction	Antifungal	*in vitro*	[48]
Pulp	Anticancer	*in vivo*	[49]
Gel	wound healing	*in vivo*	[50-51]
Gel	Antimicrobial	*in vitro*	[52]
Gel	anti-inflammatory	*in vitro, in vivo*	[53-54]
Aerial parts	hepatoprotective	*in vivo*	[55]

Josias and Hamman, investigated that the two fractions from aloes that are claimed to have anti-cancer effect include glycoproteins (lectins) and polysaccharides. The anti-tumour activity of polysaccharides isolated from *A. vera*, also showed chemo-preventative and anti-genotoxic effects against benzo [α] pyrene. The anticancer effect of aloe polysaccharides is via stimulation of the host immune response [46].

Numerous studies also reported on medicinal properties derived from different extracts of *A. vera* have already been discussed in different reports. The pharmacological elements of *A. vera* species are studied extensively via *in vivo* and *in vitro* studies [47-55]. The varied medicinal properties of *A. vera* are summarized in Table 2.

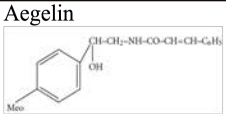
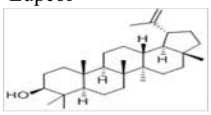
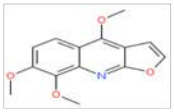
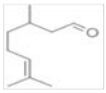
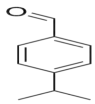
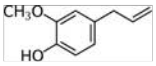
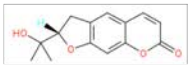
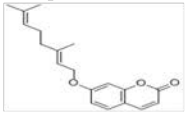
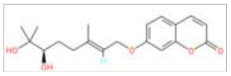
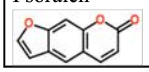
3. *Aegle marmelos*

Aegle marmelos is commonly known as bael. It is a medium-sized, armed, deciduous tree belonging to the family *Rutaceae*. It is indigenous to India and is abundantly found in the Himalayan region, West Bengal, Central and South India. A large number of compounds have been isolated from various parts of the bael tree and a few of them have been studied for their biological activities [56-67] as presented in Table 3.

A higher concentration of blood triglyceride and cholesterol level leads to atherosclerosis by arterial damage and lead to ischemic heart diseases and myocardial infarction and cerebro vascular accidents. Although modern drugs are effective in preventing cardiovascular disorders but they exert some side effects in the body. Rajadurai and Prine have reported that bael leaf extract at 100 mg/kg body weight and 200 mg/kg body weight doses for 35 days caused significant improvement on the

activities of marker enzymes, decrement of lipid peroxides, plasma lipids and lipoproteins in isoproterenol treated rats suggesting its hyperlipidaemic effect [68]. Vinodhini et al [69] have shown that antioxidant parameters like reduced glutathione, glutathione peroxidase, glutathione reductase, superoxide dismutase (SOD) displayed dose related increase in their levels and decrease in lipid peroxidation due to the treatment with bael leaf extract. Kamalakkannan and Prince have also reported that the bael fruit extract at a dose of 250 mg/kg body weight is more effective than the standard drug, glibenclamide (300 µg/kg body weight) [70].

Table 3: Some bioactive compounds from Bael

Bael compounds	Source	Biological activity	References
Aegelin 	Leaf	Antihyperglycaemic	[56]
Lupeol 	Leaf	Anti-inflammatory	[57]
Skimmianine 	Leaf	Anticancer	[58-59]
Citronellal 	Leaf	Antiseptic	[60]
Cuminaldehyde 	Leaf	Antibacterial	[61]
Eugenol 	Leaf	Antioxidant Antibacterial Hepatoprotctive	[62] [63] [64]
Marmesinin 	Leaf	Antioxidant	[56]
Aurapten 	Fruit	Heart beat inhibitor	[65]
Marmin 	Immature Fruit	Antiulcer	[66]
Psoralen 	Immature Fruit	Antispasmodic	[67]

The hydroalcoholic bael leaves extract at 400 mg/kg body weight has shown the greatest antitumor effect. This extract also possesses antiproliferative activity on MCF7 and MDA-MB-231 breast cancer cell lines [59]. Costa-Lotufo et al. [71] reported that bael leaves extract also exhibited cytotoxicity against tumor cell lines in brine shrimp lethality assay and methyl thiazolyl tetrazolium (MTT) based assay. Different organic extracts of the bael leaves possess highly significant acute and subacute anti-inflammatory, analgesic and antipyretic activities [72].

Different leaves, roots and fruits extracts of bael have been reported by Joshi and Magar to be active against many bacterial strains [73]. The essential oil obtained from the leaves exhibited antimicrobial activity against *Aeromonas sp.*, *E. coli*, *Pseudomonas salanacearum* and *Xanthomonas vesicatoria* [74]. Pitre and Srivastava have shown that the ethanolic root extract has antimicrobial activity against *Vibrio cholerae*, *Salmonella typhimurium*, *Klebsiella pneumoniae*, *E. coli*, *Pseudomonas aeruginosa*, *Bacillus subtilis* and *Staphylococcus aureus* [75]. According to Duke the antibacterial activity of leaf extract may be due to the presence of Cuminaldehyde and Eugenol because these compounds have already been demonstrated to contain activities against various pathological bacterial strains [63].

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4. *Tinospora cordifolia*

Tinospora cordifolia (*T. cordifolia*) is one of the most useful ayurvedic medicinal herbs belonging to family menispermaceae. It is called Guduchi in Sanskrit and Amrita or Giloya in Hindi. In the today's world of modern medicine, it is called as magical herb due to its property of curing a number of diseases [76].

Table 4: Active principle isolated from different parts of *Tinospora cordifolia*

Plant parts	Active principle	Reference
Stem	**Alkaloids**	
	Berberine, Palmatine	[85]
	Choline, Tinosporine	
	Glycosides	
	18-norclerodane glycoside	[86]
	Glucoside	[87]
	Tinocordiside	[88]
	Steroids	
	Ecdysterone,	[89]
	Makisterone	[90]
Roots	**Alkaloids**	
	Palmatine	[91]
Whole Plant	**Diterpenoid**	
	Furanolactone	[92]
	Tinosporon	[93]
	Columbin	[94]
Aerial plant stem	**Steroids**	
	b-sitosterol	[95]
	g-sitosterol	

It contains various chemical constituents such as alkaloids, glycosides, steroids, lactones which are active with different biological activities such as antidiabetic [77], antioxidant [78], immunomodulatory [79], hepatoprotective [80], anticancer [81] and antimicrobial [82]. *T. cordifolia* contains about 11.2% protein and rich in calcium and phosphorus [83-84]. Different chemical constituents isolated from *T. cordifolia* [85-95] have been presented in Table 4.

Agrawal et al. [77] have reported *T. cordifolia* in treatment of retinopathy in STZ-induced diabetic rats due to its anti-hyperglycemic, angiogenic, anti-inflammatory and antioxidant effects. The diabetic rats treated for 24 weeks with *T. cordifolia* extract (250mg/kg body weight), were evaluated for lenticular and fundus changes. *T. cordifolia* significantly reduced blood glucose and glycated hemoglobin in treated rats. It prevented cataract development in treated group. Angiogenic markers such as VEGF and PKC increased in diabetic retina, which reduced significantly by treatment with *T. cordifolia*. The levels of anti-inflammatory parameters such as TNF-α and IL-1β were elevated in diabetic group unlike that in treated group. *T. cordifolia* also provided defense against depletion of antioxidant indices such as glutathione and catalase.

Oral administration of the aqueous root extract of *T. cordifolia* for 6 weeks results in a significant reduction in the level of glucose in blood and urine into alloxan induced diabetic rats. The plant extract also prevented a decrease in body weight [96]. The same extract of *T. cordifolia* has been reported by Stanely group in aloxan diabetic animal model to cause a significant reduction of blood glucose and brain lipids. Aqueous root extract of *T. cordifolia* caused increase in body weight, total haemoglobin, hepatic hexokinase, reduction in activities of its hepatic glucose-6-phosphatase, serum acid phosphatase, alkaline phosphatase and lactate dehydrogenase in diabetic animals. Thus, aqueous root extract of *T. cordifolia* has hypoglycaemic and hypolipidemic properties [97].

Effect of aqueous root extract of *T. cordifolia* on modulation of hepatic function is also reported by Bishayi et al [80] with the dose of 100 mg/kg body weight for 15 days in CCl_4 intoxicated rats, which caused a significant reduction in serum levels of SGPT, SGOT, ALKP and bilirubins. Mehrotra et al [98] have reported that the hepatoprotective action in goats treated with effect of *T. cordifolia*. It caused significant clinical and hemato-biochemical improvements in CCl_4 induced hepatopathy. The aqueous root extract of *T. cordifolia* also exhibited *in vitro* inactivating property against Hepatitis B and E surface antigen up to 48-72 hrs [98].

Prince et al [99] have shown that alcoholic root extract of *T. cordifolia* administered at a dose of 100 mg/kg body weight to diabetic rats orally for six weeks normalized the antioxidant status for liver and kidney. Also the same extract was found to be more potent than glibenclamide. Premanath and Lakshmidevi have studied the anti-oxidant effects of leaves of *T. cordifolia*. Dried and powdered leaves of *T. cordifolia* were extracted with hexane, chloroform, methanol, ethanol and water. Total phenolic and flavonoid contents of different solvent extracts were determined into the different solvent extracts [100]. Ethanol extract had the highest phenol and flavonoid contents by 5.1±0.25 mg/g and 0.52±0.02 mg/g, respectively. Antioxidant assays have been carried out by using different *in vitro* models such as total reducing power, total antioxidant activity, lipid peroxidation inhibitory activity, DPPH radical scavenging activity and superoxide radical scavenging activity. Ethanol extract showed the highest total antioxidant activity of 41.4±0.45 μM Fe(II)/g. The EC_{50} values of ethanol extract for lipid peroxidation inhibitory activity and DPPH radical scavenging activity was found to be 0.1 and 0.5 mg/ml, respectively.

These results suggest that the active antioxidant compounds are better extracted in ethanol and there is a direct correlation between the total polyphenols extracted and its anti-oxidant activity. Ethnol root extract of *T. cordifolia* at the doe of 100 mg/kg body weight exhibited significant anti-stress activity compared with diazepam at the dose of 2.5 mg/kg body weight [101]. The alcoholic stem extract of *T. cordifolia* have been studied by Patel et al. [102] on the contractile response due to various agonists (such as histamine, 5-HT, bradykinin, prostaglandin E_1 and $F_2\alpha$, cholinomimetics and KCl) on smooth muscles of rat in the dose of 100 to 600 μg/mg.

The *in vitro* sensitivity of bacteria that is causative against coetaneous diseases, diarrhea and respiratory tract infection against the plant (*T. cordifolia*) extract as a primary antimicrobial agent has been shown. The concentration of 0.1 g/ml methanol extract of *T. cordifolia* showed that the zone of inhibition reflects the trend such as *E. coli* has maximum zone of inhibition (14.4 mm) followed by *S. aureus* (12.0 mm) and *S. albus* (minimum zone of inhibition) using disc diffusion method [82]. Verma et al. [81] have reported that a single application of *T. cordifolia* extract at a dose of 200, 400 and 600 mg/kg dry weight, 24 hrs prior the i.p. administration of cyclophosphamide (at the 50 mg/kg), significantly prevented the micronucleus formation in bone marrow of mice, in a dose dependent manner. In melanoma assay, C57 Bl mice when received 50% methanolic extract of *T. cordifolia* at a dose 750 mg/kg body weight for 30 days showed increase in life span with 18.91% and tumor size was significantly reduced as compared to control. *T. cordifolia* extract acted as anticarcinogenic and antimutagenic agents.

5. *Momordica charantia*

Momordica charantia Linn. (*M. Charantia*) belonging to the family of cucurbitaceae, commonly known as bitter melon and in Hindi known as Karela, is a useful medicinal plant for human health and vegetable in number of countries. The plant is a liana with flowers and yellow fruits that present red seeds when are ripe. Extracts of *M. charantia* plant, fruit pulp, seeds and leaves have been reported to have wide medicinal values in the traditional medicinal system; most often as an antidiabetic [103], antioxidant [104], antibacterial [105], anticancer [106],

antiobesity and anti-HIV agents [107].

Chemical constituents of bitter melon have been investigated and several classes of secondary metabolites as flavonoids, alkaloids and tannins have been found in it. Cucurbitane-type triterpenoids have been isolated from *M. charantia* fruits, seeds and whole plants [108]. Charantin, an anti-diabetic compound, is a typical cucurbitane-type triterpenoid in *M. charantia* and is a potential and promising substance for the treatment of diabetes. Charantin is a typical cucurbitane-type triterpenoid in *M. charantia* and is a potential substance with antidiabetic properties [109]. Patel et al [110] have developed a HPTLC method for quantitative estimation of charantin in small, big, dried fruits used in formulations and different marketed antidiabetic polyherbal formulations (PHF) [110].

Charantin, a mixture of sitosterol and stigmastadienol glucosides was isolated from karela with about 0.01% yield [111]. A decrease in blood glucose concentration was found when charantin was administered to fasted normal rabbits orally or intravenously. Charantin administered to normal rabbits intravenously or orally produced a gradual but significant fall in blood sugar.

In human subjects, karela seeds were found to lower blood glucose level in STZ induced diabetic Rabbits [112-113]. The seeds also reversed low muscle and liver glycogen levels and elevated serum cholesterol, fatty acids and triglycerides induced by STZ. Extract of karela seed in polar solvents (methanol, 50% aqueous ethanol, normal saline) showed a significant hypoglycaemic effect in fasted albino rats [114]. The methanol and saline extracts were also able to reduce adrenaline-induced hyperglycaemia. In both cases, the methanol extract was the most potent.

Protein fractions obtained from the fruit and seed of *M. charantia* have the ability to inhibit cell growth, guanylate cyelase activity and ribosomal activity [115]. It demonstrated inhibitory effects of whole plant extracts on seedling root growth, division of fertilized sea urchin eggs, rat foetal growth and the growth of Hep_2 cells in culture. They also reported a single case study of a leukemia patient in whom regular intake of the extract led to a fall in white blood cell count, and an increase in blood haemoglobin.

The growth of herpes simplex virus I [116] and human immunodeficiency virus I [117-118] is inhibited by *M. charantia* extracts. Increased T-cell count and a normalization of the CD4/CD8 ratio seemed to occur in three HIV positive patients when given with the regular doses of *M. charantia* juice by Zhang [119]. The juice was administered as a retained enema i.e. rectally. This may explain its apparent effectiveness since the active anti-viral components of *M. charantia* are believed to be the proteins such as α and β-momorcharin and which would be expected to undergo hydrolysis by pancreatic enzymes if administered by the oral route. Oral administration of *M. charantia* fruit extract (1.75 g/day for 60 days) to male dogs resulted in testicular lesions and mass atrophy of spermatogenic elements [120]. Serum enzyme was normal implying that an infertility state was induced without altering general metabolic activity in the animal. Continuous single or twice daily oral administration of *M. charantia* to 6 rabbits caused their death within a few hours of receiving this dose [121].

Some toxicological studies have observed that if the data obtained in some animal models is extrapolated to humans, the relevance of the dose and route of administration must be considered. A dose of 6-10 ml/kg body weight in animal model would represent a dose of 400 ml-1000 ml/ kg body weight for an adult human. Principal toxic properties of karela juice noted in animals are anti-fertility effects and hepatoxicity with death occurring on chronic oral treatment with doses of the order of 6 ml/kg body weight. Similar effects have not been reported in humans despite widespread use of the fruit juice both as a medicinal plant and as a vegetable.

The effect of hexane fruit extract of *M. charantia* on CCl_4 induced rats was found to up-regulate different antioxidant and detoxifying enzymes in liver of rats challenged with CCl_4 as compared to control [104]. Therefore, the hexane extract of *M. charantia* fruits has protective function against CCl_4 toxicity in rat liver when administered *in vivo* at a dose of 200 mg /kg/day i.p, for 4 consecutive days prior to CCl_4 intoxication because CCl_4 is a known hepatotoxic compound or as an agent for generation of reactive free radicals. The *in vivo* antitumor activity of the crude extract from the *M. charantia* was determined by Jilka et al. [106]. The extract inhibited tumor formation in CBA/H mice which had been given i.p. injections of 1.0 x 105 CBA/DI tumor cells (77% of the untreated mice with tumors versus 33% of the treated mice with tumors after 6 weeks).

The extract also inhibited tumor formation in DBA/2 mice which had been given i.p. injections of either 1 x 105 P388 tumor cells (0% of untreated mice survived after 30 days versus 40% survival of the treated mice). *M. charantia* contains three anti-HIV proteins: alpha- and beta momorcharin, and MAP-30, and charantin. These proteins known as alpha- and beta-momorcharin present in the seeds, fruits, and leaves have been reported to inhibit the progression of HIV-1.

Momordica Anti-HIV Protein (MAP-30) is a chemical analog of alpha momocharin and beta momocharin. MAP-30 is a basic protein of about 30 kDa molecular weight. It exhibits dose-dependent inhibition of cell-free HIV-1 infection and replication [122].

Antioxidants and their dietary sources: Tilak et al. [123] have estimated some polyphenolic compounds as antioxidants with their dietary sources. Their properties are summarized in Table 5.

In addition, the plant extracts of *Cynodon dactylon* have shown presence of plenty amount of antioxidants [124] and it has the potential to protect the STZ induced hepatic injury in rats [125].

Table 5. Ayurvedic formulations containing ingredients from medicinal plants containing antioxidant activities

Polyphenolic compounds	Dietary sources
Flavonoids with antioxidant effects: Anthocyanidins, Aurones, Chalcones, Flavones	**Fruits:** Apples, Blackberries, Blueberries, Citrus fruits, Grapes, Pears
Anthocyanidines, Aurones, Chalcones, Flavones	Raspberries, Strawberries
Flavonols, Flavan-3-ol, (Epicatechin, Catechin)	Vegetables: Beet root, Brinjal, Broccoli, Celery, Endivers, Leek, Lettuce
Flavones (Apigenin), Leuteolin, Flavonols (Kaemferol, Myricetin, Quercetin, Quercetin glycosides, Rutin, Isoflavonoid (Anisole, Cumestrol, Daidzen, Geinstein)	Onion (White and red), Pepper, Spinach, Tomatoes Legumes, Horsegram, Greengram, Lupin, Peas, Soy beans, White and black Bean spices: Cardamom, Cinamom, Coriander, Cumin.
Other polyphenols:	Beverages, Cocoa, Tea, wine (Red and white wines Sherry)
Cinammic acid, Coumarin, Condensed tannins, Hydroxy benzoic acid (Gallic acid, Protocattechuric acid, Vanillic acid, Hydroxy cinammic acid)	**Oil:** Olive oil Chocolates
Carotenoids with antioxidant effects: Astaxanthin, Bixin, Canthaxanthin, Capsorubin, α-carotenes, β-carotenes, γ-carotenes, Caocin, β-cryptoxanthin, Lutein, Lycopene, Zeaxanthin	**Fruits:** Apples, Banana, Blackberries, Blueberries, Cherries, Grapefruits, Grapes, Jack fruit, Kiwi fruit, Lemon, Mango, Melon, Orange, Papaya, Pears, Pineapple, Plum, Strawberries, Watermelon. **Vegetables:** Amaranthus, Asparagus, Beet, Beer root, Brinjal, Brocolli, Brussels, Sprout, Peach, Pineapple, Cauliflower, Cucumber, Carrots, Celery, Lettuce, Mushroom, Onion, Pepper, Tomato, Pumpkin, Spinach, Spring green, Spring onion **Cereals:** Sweet corn/Corn **Legumes:** Beans (Broad, Green Runner, Kidney, Bean Sprouts, Peas) **Spices:** Chillies, Saffron **Oil:** Red palm oil **Dairy product:** Butter, Cheese, Milk **Eggs:** Whole and Yolk, Mayonaise
Vitamin: Vit C, Vit E (α-tocopherol, tocotrenoids), Nicotinamide	Amla (Indian gooseberry), Lemon, Oranges **Oil:** Ground nut, Olive oil, Palm oil, Cashew nut, germinated pulses, Rasins.
Other Compounds: Curcumin, caffeine, Chlorophyllin, Sesaminol, Zingerone.	Coffee, Cocoa Green vegetables, Tea, Turmeric, Zinger

Very recently, the role of Drumstick leaves (*Moringa oleifera*) in regulation of diabetes-induced oxidative stress has been demonstrated [126]. The *Curcuma longa* freeze dried rhizome powder with milk [127] and the aqueous extract of *Trichosanthes dioica* fruits [128] and leaves [129] have shown to possess the antidiabetic potential in STZ induced diabetic rats. The aqueous extracts of aerial roots of *Ficus bengalensis* [130] and the seeds of *Emblica officinalis* have been shown to exhibit significant antidiabetic potential [131].

Conclusion

Medicinal herbs as potential source of therapeutics aids has attained a significant role in health system all over the world for both humans and animals not only in curing different diseases but also as potential material for maintaining proper health. Determining the biological properties of plants used in traditional medicine is helpful to the rural communities and informal settlements. Several authors are currently studying the medicinal properties of plants by isolating their active compounds by bioassay-guided fractionation from the species that showed high biological activity during screening. *A. indica*, *A. vera*, *A marmelos*, *T. cordifolia*, and *M. charantia* are used in the several ayurvedic systems of the medicine for the treatment of various ailments. All the parts of these plants have been reported as antidiabetic, antioxidant, antimicrobial, anticancer and anti-inflammatory principles. It is not that these herbal ingredients are always safe and nontoxic in nature. Therefore clear acute toxicity studies are required prior to their administration. Different biological studies conducted on these important medicinal plants revealed that they might act as excellent drugs which could be exploited as good remedy for animals as well as human beings. Therefore, these scientific investigations have relevance towards design and development of many novel, cost effective and potential chemotherapeutics against various diseases.

References

1. Chopra A, Doiphode VV: **Ayurvedic medicine: Core concept, therapeutic principles and current relevance**. *Medical Clinics of North America* 2002, **86**: 75-89.
2. Prance GT: **In: Ethno botany and the search for new drugs**. Ciba foundation symposium 185, John Wiley and sons, Chichester. 1-3, 1994.
3. Fransworth NR: **Ethnopharmacology and drug development. In: Ethno botany and the search for new drugs, Ciba foundation symposium**, 185. John Wiley and sons, Chichester 1994, 42-51.
4. Mukherjee PK, Wahil A: **Integrated approaches towards drug development from Ayurveda and other systems of medicine**. *Journal of Ethnopharmacology* 2006, **103**: 25-35.
5. UNESCO: **Culture and Health, Orientation Texts** – World Decade for Cultural Development 1988 – 1997, Document CLT/DEC/PRO – 1996, Paris, France. 129.
6. Chatterjee A, Pakrashi S: **The Treatise on Indian Medicinal Plants**. Phytochemistry 1994, **3**: 76.
7. Devmurari VP, Jivani NP: **Hepatoprotective activity of**

methanolicand aqueous extracts of *Azadirchata Indica* **leaves**. *Int. J. Pharm. Tech Res* 2010, **2**: 1037-1040.

8. Mahabub-Uz-Zaman M, Ahmed NU, Akter R, Ahmed K, Aziz MSI, Ahmed MS: **Studies on anti-inflammatory, antinociceptive and antipyretic activities of ethanol extract of** *Azadirachta indica* **leaves**. *Bangladesh J Sci Ind Res* 2009, **44**: 199-206.
9. Gupta S, Kataria M, Gupta PK, Murganandan S, Yashroy RC: **Protective role of extracts of neem seeds in diabetes caused by steptozotocin in rats**. *J. Ethnopharmacol* 2004, **90**: 185-189.
10. Sithisarn P, Roongtawan S, Gritsanapan W: **Antioxidant activity of Siamese neem tree (VP1209)**. *J Ethnopharmacol* 2005, **99**: 109-112.
11. Vinothini G, Manikandan P, Anandan R, Nagini S: **Chemoprevention of rat mammary carcinogenesis by** *Azadirachta indica* **leaf fractions: Modulation of hormonestatus, xenobioticmetabilizing enzymes, oxidative stress, cell proliferation and apoptosis**. *Food Chem Toxicol* 2009, **47**: 1852-1863.
12. Patil P, Gaikwad D, Sawane MV, Waghmare VS: **Effect of neem oil sperm mitochondrial activity**. *J. Health Allied Sci* 2009, **8**: 12-14.
13. Rojanapo W, Suwanno S, Somaree R, Glinsukon T, Thebtaranonth Y: **Screening of Antioxidants from some Thia vegetables and herbs**. *J. Sci. Thailand* 1985, **11**: 177–188.
14. Vander Nat JML, Hart AT, Vander Sluis WG, Van Dijk H, Vander Berg AJJ, De Silva KTD, Labadie RP: **Characterization of anti-complement compounds from** *Azadirachta indica*. *J. Ethnopharmacol* 1989, 27: 15-24.
15. Siddiqui S: **A note on the isolation of three new bitter principles from the neem oil**. *Current Science* 1942, **11**: 278-279.
16. Bhargava KP, Gupta MB, Gupta GP, Mitra CR: **Anti-inflammatory activity of saponins**. *Indian J. Med. Res* 1970, **58**: 724–730.
17. David SN: **Anti-pyretic of neem oil and its constituents**. *Mediscope* 1969, **12**: 25-27.
18. Pillai NR, Santhakumari G: **Hypoglycaemic activity of** *Melia Azadirachta* **Linn (Neem)**. *Indian J Med Res* 1981, **74**: 931-933.
19. Pillai NR, Suganthan D, Seshadri C, Santhakumari G: **Anti-gastric ulcer activity of nimbidin**. *Indian Journal of Medical Research* 1978, **68**: 169-175.
20. Murthy SP, Sirsi M: **Pharmacological studies on** *Melia azadirachta*. *Indian J. Physiol. Pharmacol* 1958, **2**: 387–396.
21. Sharma VN, Saksena KP: **Spermicidal action of Sodiu Nimbinate**. *Indian Journal of Medical Research* 1959, **47**: 322-324.
22. Rochanakij S, Thebtaranonth Y, Yenjal CH, Yuthavong Y: **Nimbolide, a constituent of Azadirachta indica, inhibits Plasmodium falciparum in culture**. Southeast Asian *J. Trop. Med. Public Health* 1985, **16**: 66–72.
23. Rao BS, Nazma, Rao JM: **Antifungal activity of gedunin**. *Current Science* 1977, **46**: 714–716.
24. Khalid SA, Duddect H, Gonzalez-Sierra MJ: **Potential Antimalaria, Condidate from African Plants; in vitro Approach Using a** *Plasmodium Falciparum*. *J. Nat. Prod* 1989, **52**: 922–927.
25. Jones IW, Denholm AA, Ley SV, Lovell H, Wood A, Sinden RE: **Sexual development of malaria parasites is inhibited in vitro by the neem extract azadirachtin, and its semi-synthetic analogues**. *FEMS Microbiol Lett* 1994, **120**: 267–273.
26. Van der Nat JM, Van der Sluis WG, 'tHart LA, Van Dijk H, de Silva KT, Labadie RP: **Activity-guided isolation and identification of** *Azadirachta indica* **bark extract constituents which specifically inhibit chemiluminescence production by activated human polymorphonuclear leukocytes**. *Planta Med* 1991, 57: 65-68.
27. Fujiwara T, Takeda T, Ogihara Y, Shimizu T, Tomita Y: **Studies on the structure of polysaccharides from the bark of Melia azadirachta Chem**. *Pharm. Bull* 1982, **30**: 4025–4030.
28. El-Hawary ZM, Kholief TS: **Biochemical studies on hypoglycemic agents**. *Arch. Pharmacol. Res* 1990, **13**: 108–112.
29. Tidjani MA, Dupont C, Wepierre J: **Antiinflammatory activity of Azadirachta indica.** *Planta Med. Phytothe* 1989, **23**: 259–266.
30. Lorenz HKP: **Neem tree bark extract in the treatment of inflammatory stomatitis**. *J. Praxis* 1976, **8**: 231-233.
31. Gandhi M, Lal R, Sankaranarayanan A, Banerjee CK, Sharma PL: **Acute toxicity study of the oil from** *Azadirachta indica* **seed (neem oil)**. *J. Ethnopharmacol* 1988, **23**: 39-51
32. Anofi O, Tom A, Olubukola OL, Musa TY: **Toxicity profile of ethanolic extract of** *Azadirachta indica* **stem bark in male Wistar rats**. *Asian Pacific Journal of Tropical Biomedicine* 2012, **2**: 811-817.
33. Mahdi AA, Chandra A, Singh RK, Shukla S, Mishra LC, Ahmad S: **Effect of herbal hypoglycemic agents on oxidative stress and antioxidant status in diabetic rats**. *Indian Journal of Clinical Biochemistry* 2003, **18**: 8-15.
34. Roy MK, Kobori M, Takenaka M, Nakahara K, Shinmoto H, Isobe S, Tsushida T: **Antiproliferative effect on human cancer cell lines after treatment with nimbolide extracted from an edible part of the neem tree (***Azadirachta indica***).** *Phytother Res* 2007, 3: 245-250.
35. Basak SP, Chakraborty DP: **Chemical investigations of** *Azadirachta indica* **leaf**. *J. Indian Chem Soc* 1968, **45**: 5466–5467.
36. Bramley PM, Pridham JB: **The relative antioxidant activities of plant derived polyphenolic flavonoids**. *Free Radic Res* 1995, **4**: 375–383.
37. Bonic PJD: **Sterols and sterolins: new drugs for the immune system**? *Drug Discovery Today* 2002, **7**: 775–778.
38. Yanpallewar SU, Sen S, Tapas S, Kumar M, Raju SS, Acharya SB: **Effect of** *Azadirachta indica* **on paracetamol-induce hepatic damage in albino rats.** *Phytomedicine* 2002, **9**: 391–396.
39. Yongchaiyudha S, Rungpitarangsi V, Bunyapraphatsara N, Chokechaijaroenporn O: **Antidiabetic activity of** *Aloe vera* **juice. Clinical trial in new cases of diabetes mellitus.** *Phytomedicine* 1996, **3**: 241-243.
40. Rajasekaran S, Sivagnanam K, Ravi K, Subramanian S: **Beneficial effects of** *aloe vera* **gel extract on lipid profile status in rats with streptozotocin diabetes. Clin**. *Exp. Pharmacol. Physiol* 2006, **33**: 232-237.
41. De Feudis FV, Papadopoulos V, Drieu K: *Ginkgo biloba* **extracts and cancer: a research area in its infancy**. *Fundam Clin Pharmacol* 2003, **17**: 405-417.
42. Takeoka GR, Dao LT: **Antioxidant constituent of almond [***Prunus dulcis* **(Mill.) D.A. Webb.] hulls.** *J Agric Food*

Chem 2003, **51**: 496-501.

43. Dixit S, Ali H: **Anticancer activity of medicinal plant extract-a review**. *J. Chem. & Cheml. Sci* 2010, **1**: 79-85.
44. Naveena BK, Bharath, Selvasubramanian: **Antitumor activity of** *Aloe vera* **against** *Ehrlich Ascitis* **Carcinoma (EAC) in swiss albino mice**. *International Journal of Pharma and Bio Sciences* 2011, **2**: 1-10.
45. Miladi S, Damak M: **In vitro antioxidant activities of** *aloe vera* **leaf skin extracts**. *Journal de la Société Chimique de Tunisie* 2008, **10**: 101-109.
46. Josias H, Hamman P: **Composition and Applications of** *Aloe vera* **Leaf Gel**. *Molecules* 2008, **13**: 1599-1616.
47. Singh RP, Banerjee S, Rao AR: **Effect of Aegle marmelos on biotransformation enzyme systems and protection against free-radiacal-mediated damage in mice**. *J Pharm Pharmacol* 2000, **52**: 991.
48. Rodríguez DJD, Hernández-Castillo D, Rodríguez-García R, Angulo-Sánchez JL: **Antifungal activity in vitro of** *Aloe vera* **pulp and liquid fraction against plant pathogenic fungi**. *Industrial Crops and Products* 2005, **21**: 81-87.
49. Akev N, Turkay G, Can A, Gurel A, Yildiz F, Yardibi H, Ekiz EE, Uzun H: **Effect of** *Aloe vera* **leaf pulp extract on** *Ehrlich ascites* **tumours ijjjn mice**. *Eur. J Cancer Prev* 2007, **16**: 151-157.
50. Chithra P, Sajithlal GB, Chandrakasan G: **Influence of** *Aloe vera* **on the healing of dermal wounds in diabetic rats**. *Journal of Ethnopharmacology* 1998, **59**: 195-20.
51. Davis RH, Leitner MG, Russo JM, Byrne ME: **Wound healing. Oral and topical activity of** *Aloe vera*. *J Am Podiatr Med Assoc* 1989, **79**: 559- 562.
52. Habeeb F, Shakir E, Bradbury F, Cameron P, Taravati MR, Drummond AJ, Gray AI, Ferro VA: **Screening methods used to determine the anti-microbial properties of** *Aloe vera* **inner gel**. *Methods* 2007, **42**: 315-320.
53. Langmead L, Makins RJ, Rampton DS: **Anti-inflammatory effects of** *Aloe vera* **gel in human colorectal mucosa** *in vitro*. *Aliment Pharmacol Ther* 2004, **19**: 521-527.
54. Park MY, Kwon HJ, Sung MK: **Dietary aloin, aloesin, or aloe-gel exerts anti-inflammatory activity in a rat colitis model**. *Life Sci* 2011, **88**: 486-492.
55. Chandan BK, Saxena AK, Shukla S, Sharma N, Gupta DK, K. Suri A, Suri J, Bhadauria M, Singh B: **Hepatoprotective potential of** *Aloe barbadensis* **mill. against carbon tetrachloride induced hepatotoxicity**. *Journal of Ethnopharmacology* 2007, **111**: 560-566.
56. Arul V, Kumaraguru S, Dhananjayan R: **Effects of aegeline and lupeol the two cardioactive principles isolated from the leaves of** *Aegle marmelos* **corr**. *J. Pharm Pharmacol* 1999, **51**: 252.
57. Rastogi RP, Mehrotra BN: **In compendium of Indian Medicinal plants** vol.5 edited by R. P. Rastogi (C.D.R.I., Lucknow & Publications & Information Directorate, New Delhi): 18, 1998.
58. Takase H, Yamamoto K, Hirano H, Saito Y, Yamashita A: **Pharmacological profile of gastric mucosal protection by marmin and nobiletin from a traditional herbal medicine, Aurantee fructus immaturus.** *Jpn J Pharmacol* 1994, **66**: 139.
59. Lambertini E, Piva R, Khan MT, Lampronti I, Bianchi N, Borgatti M, Gambari R: **Effect of extrcats from Bangladeshi medicinal plants on in vitro proliferation of human breast cancer cell lines and expression of estrogen receptors alpha gene**. *Int. J. Oncol* 2004, **24**: 419.
60. Huang KC: **The pharmacology of chinese herbs** (CRC press)," Boca Raton, FL, 388, 1993.
61. Jagetia GC, Venkatesh P, Baliga MS: **Fruit extract of** *Aegle marmelos* **protects mice against radiation-induced lethality**. *Integr Cancer Ther* 2004, **3**: 323.
62. Vidhya N, Devaraj SN: **Antioxidant effect of eugenol in rat intestine**. *Indian J Exp Biol* 1999, **37**: 1192.
63. Duke JA: Handbook of biologically active phytochemicals and their activities. (CRC Press); 1992.
64. Sherwood ER, Toliver-Kinsky T: **Mechanism of the inflammatory response.** *Best Pract Res Clin Anaesthesiol* 2004, **18**: 385.
65. Rastogi RP, Mehrotra BN: **In compendium of Indian Medicinal plants** vol.4, Edited by R. P. Rastogi (C.D.R.I., Lucknow & Publications & Information Directorate, New Delhi): 15, 1995.
66. Hajra PK, Nair VJ, Daniel P: **Flora of India**, (Botanical Survey of India, Calcutta) 1997, **4**: 264\
67. Lamba B, Bhargava KP: **Activity of some synthetic natural products against experimental ankylostomiasis.** *Indian J. Pharmacol* 1969, **1:** 6.
68. Rajadurai M, Prince P S: **Comparative effects of** *Aegle marmelos* **extract and alpha-tocopherol on serum lipids, lipid peroxides, and cardiac enzymeslevels in rats with isoprotereno-induced myocardial infarction.** *Singapore Med J*. 2005, **46**: 78.
69. Vinodhini S, Malairajan S, Hazeena B: **The hepatoprotective effect of Bael leaves (***Aegle Marmelos***) in alcohol induced liver injury in albino rats.** *International Journal of Science & Technology* 2007, **2**: 83-92.
70. Kamalakkannan N, Prince PS: **Hypoglycamic effects of water extract of** *Aegle marmelos* **fruits in Streptozotocin diaebtic rats**. *J. Ethnopharmacol* 2003, **87**: 20.
71. Costa Lotufo LV, Khan MT, Ather A, Wilke DV, Jimenez PC, Pessoa C: **Studies of the anticancer potential of plants used in bangladeshi folk medicine**. *J Ethnopharmacol* 2005, **99**: 21.
72. Arul V, Miyazaki S, Dhananjayan R: **Studies on the anti-inflammatory antipyretic, analgesic properties of the leaves of** *Aegle marmelos* **Corr**. *J. Ethnopharmacol* 2005, **96**: 159.
73. Joshi CG, Magar NG: **Antibiotic activity of some Indian medicianl plants**. *J Sci Ind Res* 1952, **11**: 261.
74. Pandey DK, Asthana A, Tripathi NN, Dixit SN: **Volatile plant products vis-a-vis potato pathogenic bacteria**. *Indian Perfum* 1987, 1981, **25**: 10.
75. Pitre S, Srivastava SK: **Parmacological and phytochemical studies on the roots of** *Aegle marmelos*. *Fitoterapia* 1987, **58**: 194.
76. Srivastava P: *Tinospora cordifolia* **(Amrita)-Amiracle herb and lifeline too many diaseses.** *International Journal of Medicinal and Aromatic Plants* 2011, **1**: 57-61.
77. Agrawal SS, Naqvi S, Gupta SK, Srivastava S: **Prevention and management of diabetic retinopathy in STZ diabetic rats by** *Tinospora cordifolia* **and its molecular mechanisms**. *Food Chem Toxicol* 2012, **50**: 3126-3132.
78. Sharma M, Joshi S: **Comparison of anti-oxidant activity of** *Andrographis paniculata* **and** *Tinospora cordifolia* **leaves**. *J Curr Chem Pharm Sc* 2011, **1**: 1-8.
79. Desai VR, Kamat JP, Sainis KB: **An immunomodulator from** *Tinospora cordifolia* **with antioxidant activity in cell free sysem**. *Proceeding of Indian Academy of Science* 2002, **114**:

713-719.

80. Bishayi B, Roychowdhury S, Ghosh S, Sengupta M: **Hepatoprotective and immunomodulatory properties of** *Tinospora cordifolia* **in CCl_4 intoxicated mature albino rats**. *The Journal of Toxicological Sciences* 2002, **27**: 139-146.
81. Verma R, Chaudhary HS, Agrawal RC: **Evaluation of Anticarcinogenic and Antimutagenic Effect of** *Tinospora cordifolia* **in Experimental Animals.** *J Chem Pharm Res* 2011, **3**: 877-881.
82. Verma DR, Kakkar A: **Antibacterial activity of** *Tinospora cordifolia***.** *Journal of Global Pharma Technology* 2011, **3**: 8-12.
83. Khosla RL, Prasad S: **Pharmacognostical studies of Guduchi (***Tinospora cordifolia* **Miers)**. *Journal of Research in Indian Medicine* 1971, **6**: 261-269.
84. Zhao TF, Wang X, Rimando AM, Che C: **Folforic medicinal plants:** *Tinospora sagittata* **var. cravaniana and** *Mahonia bealei***.** *Planta Medica* 1991, **57**: 505.
85. Kumar S, Verma NS, Pande D, Srivasrava PS: **In vitro regeneration and screening of berberine in Tinospora cordifolia**. *Journal of Medicinal and Aromatic Plant Sciences* 2000, **22**: 61.
86. Khan M. A, Gray AL, Waterman PG: **Tinosporaside an 18-norclerodane glucoside from** *Tinospora Cordifolia*. *Phytochemistry* 1989, **28**: 273-275.
87. Ghosal S, Vishwakarma RA: **Tinocordiside, a new rearranged cadinane sesquiterpene glycoside from** *T. cordifolia*. *Journal of Natural Products* 1997, **60**: 839-841.
88. Sipahimalani AT, Noerr H, Wagnor H: **Phenyl propenoid glycosides and tetrahydro furanlignan glycosides from the adaptogenic plant drugs** *T. cordifolia* **and** *Drypetes rox burghii***.** *Planta Medica* 1994, **60**: 596-597.
89. Pradhan P, Gangan VD, Sipahimalani AT, Banerji A: **Two phytoecdysterones from** *Tinospora cordifolia***: Structural assignments by 2D NMR spectroscopy**. *Indian Journal of Chemistry Section B* 1997, **36**: 958-962.
90. Gangan VD, Pradhan P, Sipahimalani AT: **Phytoecdysones from** *Tinospora cordifolia***: structural elucidation of ecdysterone and makisterone A by 2D NMR spectroscopy**. *Indian Journal of Chemistry Section B* 1997, **36:** 787-792.
91. Sarma DNK, Padma P, Khosa RL: **Constitutes of** *Tinospora cordifolia* **root**. *Fitoterapia* 1998, **69**: 541-542.
92. Hanuman JB, Bhatt RK, Sabata BK: **Aditerpenoid furano lactone from** *Tinospora cordifolia*. *Phytochemistry* 1986, **25**: 1677-1680.
93. Qudrat-I-Khuda M, Khaleque A, Bashir A, Roufk MDA, Ray N: **Studies on** *T inospora cordifolia***-Isolation of tinosporon, tinosporic acid and tinosporol from fresh creeper**. *Scientific Research* 1966, **3**: 9-12.
94. Ahmad M, Kazi AB, Karim R, Khaleque A, Miah MAW: **Structure of tinosporide, a furanoid diterpene from** *Tinospora cordifolia*. *Journal of Bangladesh Academy of Sciences* 1978, **2**: 25-30.
95. Pathak AK, Agrawal PK, Jain DC, Sharma RP, Howarth OW: **NMR studies of 20b- hydroxy ecdysone, a steroid, isolated from** *Tinospora cordifolia*. *Indian Journal of Chemsirty Section* 1995, **34**: 674-676.
96. Stanley MPP, Menon VP: **Antioxidant action of** *Tinospora cordifolia* **root extract in alloxan diabetic rats.** *Phytotherapy Research* 2001, **15**: 213-218.
97. Stanley P, Prince M, Menon VP: **Hypoglycaemic and other related actions of** *Tinspora cordifolia* **roots in alloxan induced diabetic rats**. *Journal of Ethnopharmacology* 2000, **70**: 9-15.
98. Mehrotra R, Katiyar CK, Gupta AP: **Hepatoprotective compositiions and composition for treatment of conditions related to hepatitis B and E infection**. US Patent No. 749296, 2000.
99. Prince PS, Padmanabhan MP, Menon V: **Restoration of antioxidant defence by ethnolic** *Tinospora cordifoia* **root extract in alloxan induced diabetic rats and Kidney**. *Phytotherapy Research* 2004, **18**: 785-787.
100. Premanath R, Lakshmidevi N: **Studies on Anti-oxidant activity of** *Tinospora cordifolia* **(Miers.) Leaves using** *in vitro* **models**. *Journal of American Science* 2010, **6**: 1-8.
101. Sarma DNK, Khosa RL, Chaurasia JPN, Sahai M: **Antiulcer activity of** *Tinospora cordifolia* **meirs and Cantella asiatica linn. Extracts.** *Phytotherapy Research* 1995, **9**: 589.
102. Patel SR, Goyal RK, Shah DS: **Studies on the pharmacological effects of** *Tinospora cordifolia*. *J Res Ind Med* 1977, **13**: 46.
103. Singh N, Gupta M, Sirohi P, Varsha P: **Effects of alcoholic extract of** *Momordica charantia* **(Linn.) whole fruit powder on the pancreatic islets of alloxan diabetic albino rats.** *Journal of Environmental Biology* 2008, **29**: 101-106.
104. Semiz A, Sen A: **Antioxidant and chemoprotective properties of** *Momordica charantia* **L. (bitter melon) fruit extract.** *African Journal of Biotechnology* 2007, **6**: 273-277.
105. Costa JGM, Nascimento EMM, Campos AR, Rodrigues FFG: **Antibacterial activity of** *Momordica charantia* **(Curcubitaceae) extracts and fractions**. *Journal of Basic and Clinical Pharmacy* 2011, **2**: 45-51.
106. Jilka C, Strifler B, Fortner GW, Hays EF, Takemoto DJ: *In Vivo* **Antitumor Activity of the Bitter Melon** *(Momordica charantia)*. *Cancer Research* 1983, **43**: 5151-5155.
107. Trivedi RV, Wadher KJ, Taksande JB, Mahore JG, Umekar MJ: *Momordica charantia***: A Natural and Safe Approach for the Treatment of HIVInfection**. *Int J of Pharm Tech Researc* 2011, **3:** 1660-1666.
108. Raman A, Lau C: **Anti-Diabetic Properties and Phytochemistry** *Momordica charantia L.* **(Cucurbitaceae)**. *Phytomedicine* 1996, **2**: 349-362.
109. Krawinkel MB, Keding GB: **Bitter gourd (***Momordica charantia***): a dietary approach to hyperglycaemia**. *Nutr Res* 2006, **64**: 331-337.
110. Patel PM, Patel KN, Patel NM, Goyal RK: **Development of HPTL method for estimation of charantin in herbal formulations**. *Pharmacognosy Magazine* 2006, **2**: 224-226.
111. Lodikar MM, Rajarama Rao MR: **Note on a hypoglycaemic principle isolated from the fruits of** *Momordica charantia*. *J. Univ. Bombay* 1961, **29**: 223-224.
112. Kedar P, Chakrabarti CH: **Effects of bittegourd (***Momordica charantia***) seed and glibenclamide in streptozotocin induced diabetes mellitus**. *Indian J. Exp. Biol* 1982, **20**: 232-235.
113. Grover JK, Gupta SR: **Hypoglycaemic activity of seeds of** *Momordica charantia*. *Eur. J. Pharmacol* 1990, **183**: 1026-1027.
114. Dubey DK, Biswas AR, Bapna JS, Pradhan SC: **Hypoglycaemic and antihypoglycaemic effects of** *Momordica charantia* **seed extracts in albino rats**. *Fitoterapia* 1987, **LVIII**: 387-390.
115. West ME, Sidrak GH, Street SPW: **The anti-growth properties of extract from** *Momordica charantia L***.** *West Indian J Med* 1971, **XX**: 25-34.
116. Foa-Tomasi L, Campadelli-Fiume G, Barbieri L, Stirpe E: **Effect**

of Ribosome inactivating proteins on virus infected cells. Inhibition of virus multiplication and of protein synthesis. *Arch. Virol* 1982, **71**: 323-332.

117. Lifson JD, McGrath MS, Yeung HW, Hwang K: **International Patent No. W088/0912**, 1988.
118. Lee-Huang S, Huang PL, Nara PL, Chen HC, Kung HE, Huang P, Hunag HL, Huang PL: **MAP 30: a new inhibitor of HIV-1 infection and replication**. *FEBS Lett* 1990, **272**: 102-118.
119. Zhang QC: **Preliminary report on the use of** *Momordica charantia* **extract by HIV patients.** *J Naturpath Med* 1992, **3**: 65-69.
120. Dixit VP, Khanna P, Bhargava SK: **Effects of Momordica charantia L. fruit extract on the testicular function of dog**. *Planta Med* 1987, **34**: 280-286.
121. Sharma VN, Sogani RK, Arora RB: **Some observations on hypoglycaemic activity of** *Momordica charantia***.** *Indian J Med Res* 1960, **48**: 471-477.
122. Lee-Huang S, Huang PL, Bourinbaiar AS, Chen HC, Kung HF: **Inhibition of the integrase of human immunodeficiency virus (HIV) type 1 by anti-HIV plant proteins MAP 30 and GAP 31**. *Proc Natl Acad Sci USA* 1995, **92**: 8818-8822.
123. Tilak JC, Devasagayam TPA, Lele RD: **Cardioprotective properties of some Indian Medicinal plants. A Review and possible mechanisms**. *Biochem Pharmacol* 2004, **10**: 210-215.
124. Rai PK, Jaiswal D, Rai DK, Sharma B, Watal G: **Antioxidant potential of oral feeding of** *Cynodon dactylon* **extract on diabetes induced oxidative stress**. *J. Food Biochem* 2010, **34**: 78-92.
125. Singh SK, Rai PK, Jaiswal D, Rai DK, Sharma B, Watal G: **Protective effect of** *Cyanodon dactylon* **against STZ induced hepatic injury in rats**. *J. Ecophysiology & Occupational Health* 2008, **8**: 195-199.
126. Jaiswal D, Rai PK, Mehta S, Chatterji S, Shukla S, Rai DK, Sharma G, Sharma B, Watal G: **Role of Drumstick Leaves (***Moringa oleifera***) in Regulation of Diabetes-induced Oxidative Stress**. *Asian Pacific Journal Of Tropical Medicine* 2013, **6**: 426-432.
127. Rai PK, Jaiswal D, Rai DK, Sharma B, Watal G: **Effect of** *Curcuma longa* **freeze dried rhizome powder with milk in STZ induced diabetic rats**. *Indian J Clinical Biochem* 2010, **25**: 175-181.
128. Rai PK, Jaiswal D, Rai DK, Sharma B, Watal G: **Effect of water extract of** *Trichosanthes dioica* **fruits in STZ induced severe diabetes in rats**. *Indian J. Clin. Biochem* 2008, **23**: 387-390.
129. Rai PK, Jaiswal D, Singh RK, Gupta RK, Watal G: **Glycemic properties of** *Trichosanthes dioica* **leaves**. *Pharmaceutical Biology* 2008, **46**: 894-899.
130. Singh RK, Mehta S, Jaiswal D, Rai PK, Watal G: **Antidiabetic effect of** *Ficus bengalensis* **aerial roots in experimental animals**. *Journal of Ethnopharmacology* 2009, **123**: 110-114.
131. Mehta S, Singh RK, Jaiswal D, Rai PK, Watal G: **Antidiabetic activity of** *Emblica officinalis* **in animal models**. *Pharmaceutical Biology* 2009, **47**: 1050-1055.

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Dr. Bechan Sharma, Professor/Ex-Chairman, Department of Biochemistry, Allahabad University, India, has completed his higher education from Banaras Hindu University-Varanasi, India. He completed his doctoral research at Central Drug Research Institute-Lucknow, India. The areas of his research interests include Molecular Biology, Tropical Diseases, Phytochemistry and Toxicology. With 25 years of teaching / research experience, he has received number of Awards/Honors. He has published >100 research papers, Books and book chapters, and molecular methods in peer reviewed Journals with high impact factors and produced 10 Ph.D.s. He has one US patent students. He is member/life member of several national/international scientific societies. He is Chief Guest Editor of CMB-France, Chief Editor, AJPR and JBR, Associate Editor/Member for 50 Journals and honorary reviewer for 85 scientific journals. As a visiting scientist in USA and Italy, France, Thailand, Germany, Iran, Kuwait, Turkey and Brazil, he has completed different research projects.

Rakesh Kumar Singh, PhD: Biography

Dr. Rakesh K Singh received his higher education from University of Allahabad-India. He has been awarded with SRF (CSIR-New Delhi) and has worked in different research projects. His research area includes free radical biology and medicinal chemistry of natural products. He has published 10 research papers and two book chapters. He has isolated, purified and characterized different herbal principles and has shown their therapeutic applications. The present paper deals with an updated account of bioactive principles of five important traditional Indian plants containing therapeutic potential against various diseases.

