

Herbal Medicinal Plant for Disease Including Tuberculosis: A Critique

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Abstract

Medicinal plant including herbal medicine/material contains more active analogues or active principles also called as natural products such as alkaloids, flavonoids, terpenoids, essential oils, flower absolutes. Herbal medicines have a strong traditional or conceptual base and the potential to be useful as drugs in terms of safety and effectiveness leads for treating Tuberculosis. World Health Organization (WHO) has made an attempt to identify all medicinal plants used globally and listed more than 20,000 species. According to the WHO more than 80% of the world's population realize on traditional herbal medicine for their primary health care. Although herbal medicine has existed since the dawn of time, our knowledge of how plants actually affect human physiology remains largely unexplored. Numbers of plants are claiming various medicinal uses and a lot of research is going for the treatment of tuberculosis. The potential of herbal medicinal plants to combat with the disease is increasing more and more attention as they have lesser side effects as compare to the routine medicines used. Plants like *Abutilon indicum*, *Allium cepa*, *Andrographis peniculata* are largely studied for Tuberculosis treatment and management. This innovative effort has been made for the enrichment and indirect contribution in Science and Technology.

Keywords: Medicinal Plant; Secondary Metabolites; Tuberculosis; Health and Disease.

Introduction

The traditional practice of herbal drugs comprise of medicinal plants, minerals, and organic matter; etc. Herbal drugs constitute only those traditional medicines, which primarily use plant preparations for therapy. The earliest recorded evidence of their use in Indians, Chinese, Egyptians, Greek, Roman and Syrian texts dates back to about 5000 years. The herbal/traditional medicine had been devised from rich traditions of ancient civilization and scientific heritage. Plant based active principles can be derived from any part of the plant like bark, leaves, flowers, roots, fruits, seeds, and the others.

India is one among the 25 hotspots of the richest and highly endangered eco-regions of the world. Plants have been the major source of drugs in Indian system of medicine and other ancient systems in the world. The Indian tradition has an ancient heritage of traditional medicine. Indian traditional medicines based on various systems including Ayurveda, Siddha, Unani and Homeopathy. With the emerging worldwide interest in adopting and studying traditional systems and exploiting their potential based on different health care systems, the evaluation of the rich heritage of traditional medicine is essential (Saha R, *et al.* 2011). Development of traditional herbal medicines into a modern drug of great therapeutic value is exemplified by the discovery of reserpine, a hypotensive drug from the roots of *rauwolfia serpentina* (Trease and Evans 1989). In year 2001, Iqbal *et. al* worked on Antimicrobial and phytochemical studies on 45 Indian medicinal plants

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against multi-drug resistant human pathogens. There are list of plants which were traditional in therapeutic uses and medically important.

Table 1: Showing List of plants tested for anti tuberculosis action on Lowenstein Jensen Medium (adopted from Renu Gupta *et al.* 2010)

Botanical Name/Family	Common Name	Part used	Extracts
<i>Acalypha indica</i> L. (Euphorbiaceae)	Acalypha	Leaf	Water Extract
<i>Adhatoda vasica</i> Nees. (Acanthaceae)	Vasaka	Leaf	Water Extract
<i>Allium cepa</i> L. (Alliaceae)	Onion	Bulb	Water Extract
<i>Allium sativum</i> L. (Alliaceae)	Garlic	Clove	Water Extract
<i>Aloe vera</i> L. (Aloaceae)	Aloevera	Leaf	Pure gel

Biological Properties of Medicinal Plants

Abutilon Indicum

Traditional potential medicinal usage

Tonic

Ancient Indian doctors including Charak and Sushruta made use of extract of the entire plant to promote vitality to their patients. They considered it a revitalizing nerving tonic and an aphrodisiac. The root was considered the better part for this purpose. In southern India the root is used for neurological disorders including treatment of hemiplegia, Bell's palsy, sciatica and debility (C.P. Khare, 2004).

Gastrointestinal Diseases

The demulcent property of extracts of *A. indicum* is made use in the treatment of various gastrointestinal disorders. The extract together with clarified butter treats diarrhoea and biliousness (C.P. Khare, 2004) (K.M.Nadkarni, 1976).

The high fiber content of the leaves and the mucilaginous property is taken advantage in the treatment of haemorrhoids. A decoction of the leaves is a good mouth wash for toothaches and gum ailments. Finely powdered seeds are given as a laxative.

Respiratory Diseases

The powdered flowers of *A. indicum* are a remedy for cough as recommended by the Ayurvedic and Unani systems. In the west it is the roots that is used to protect the respiratory system. A decoction of it is given to treat bronchitis and chest pains.

Genito-urinary Diseases

Western herbal medicine believed *A. indicum* has protective properties towards the urinary system. The roots are considered diuretic and its decoction is given for all types of dysurias. It is the medicine prescribed by Unani practitioners for strangury,

polyuria and haematuria. The seeds on the other hand were given to treat impotency and spermatorrhoea. The seeds are distinctly useful in gonorrhoea, gleet and chronic cystitis. The leaves and roots too could be used to treat gonorrhoea and other forms of urethritis.

Other uses

The powdered herb was used for menometrorrhagia. The leaves are used to treat various skin diseases including wounds and ulcers while the seeds are used for leprosy.

Pharmacological Study

Antidiabetic Activity

Seetharam *et al.* (2002) found that both the aqueous and alcoholic extracts of the leaves of *A. indicum* had significant hypoglycaemic effects in normal rats 4 hours after administration. Adisakwattan *et al.* (2009) further looked into the alcoholic (methanol) leaf extract's hypoglycaemic activity and observed that the extract was able to suppress the postprandial hyperglycaemia by inhibiting α -glucosidase and sucrase activities in the intestine. The effects of aqueous leaf extract showed that in addition to inhibition of β -glucosidase and sucrase, this extract was found to stimulate the insulin production by the β -cells of the pancreas (Krisanapun C, *et al.* 2009).

Hepatoprotective activity

The aqueous extract of *A. indicum* showed significant hepatoprotective activity when it was found the it was able to reduce biochemical parameter changes as a result of exposure of experimental rats to CCl_4 and Paracetamol (Porchezian E, 2005).

Analgesic Activity

Eugenol was isolated from *A. indicum* using

bioactivity guided isolation. Eugenol was found to possess the ability to inhibit acetic acid induced writhing in mice and prolonged tail flicking time (Ahmed M, *et al.* 2000) this indicates that the extract possesses significant analgesic activity via both peripheral and central mechanism.

Immunomodulatory Activity

Aqueous and ethanol extracts of the leaves of *A. indicum* were assessed for the immunomodulatory activity using various animal models. The results showed that there was significant increase in the production of circulating antibody titre in response to sheep red blood cells, increase in both primary and secondary haemagglutination antibody, a significant potentiation of delayed type hypersensitivity reaction.

There was also a significant increase in percentage of neutrophils adhesion to nylon fibre and phagocytic activity. The results indicate that the extracts were able to trigger both specific and non-specific immunological activity and that this could be attributed to the flavonoids content (Dashputre N. L. *et al.* 2010).

Antimicrobial Activity

Methanolic extract of the leaves of *A. indicum* was found to have remarkable antifungal activity against *Trichophyton rubrum*. This activity may be due to the presence of flavonoids in the extract especially Quercetin (Rajalakshmi Padma Vairavasundaram, 2009).

Antioxidant Activity

Yasmin *et al.* (2010) studied the antioxidant activity of organic solvent extracts of aerial parts and roots of *A. indicum*. They found that all the extracts contain both slow reacting and fast reacting antioxidant.

Chemical Constituents of the Plant

Gallic acid, asparagine, fructose, galactose, glucose, beta-sitosterone, vanillic acid, p-coumaric acid, p-hydroxybenzoic acid, caffeic acid, fumaric acid, p-beta-D-glycosyloxybenzoic acid, leucine, histidine, threonine, serine, glutamic acid, aspartic acid and galacturonic acid, allantolactone, isoallantolactone, threonine, glutamine, serine, proline, glycine, alanine, cysteine, methionine, isoleucine, valine, leucine, tyrosine, phenylalanine, histidine, lysine, arginine.

Allium Cepa

Traditional Medicinal Application

Due to the anti-inflammatory agents in onions they help reduce the severity of symptoms associated with conditions such as the pain and swelling of the osteo- and rheumatoid arthritis, the allergic inflammatory response of asthma, and the respiratory congestion associated with common colds. The onions anti-inflammatory effects are not only due to their vitamin C and quercetin, but other active components called isothiocyanates have made onions a good ingredient for soups and stews during cold and flu season. WHO recommends the use of fresh onion extracts for treating coughs, colds, asthma, bronchitis and also relieving hoarseness. The World Health Organization also supports the use of onions for the treatment of appetite loss and preventing atherosclerosis.

Pharmacological Study

The fleshy bulb that grows below the ground is used medicinally as well as for food. Onion is believed to have a positive effect on the circulatory system. It has been used as a diuretic to reduce swelling. It is also thought to help reduce arteriosclerosis by lowering blood cholesterol levels and preventing the formation of blood clots. Onion has been used to treat diabetes and is reputed to lower blood sugar levels. Externally; fresh onion juice is used to prevent bacterial and fungal infections. It can be applied to wounds and stings on the skin, used to remove warts, used to stimulate hair growth, and even used to reduce unwanted skin blemishes. Warm onion juice dropped in the ear is said to help relieve earache. Baked onion is used to draw pus from abscesses. The onion also may be of benefit in cardiovascular disease, as it possesses hypolipidemic effects and has anti-platelet actions, retarding thrombosis. But certain lipid-reducing and blood pressure-lowering effects in humans have not yet been clinically proven. Some studies have been performed concerning diabetes treatment by onion with promising results in animal experimentation. Although more research is needed on the use of onion as a treatment for diabetes in humans, many articles describe onion's benefits in improving glucose levels. The onion also is a proven antioxidant and may be helpful in treating certain cancers. Green Onion as Alternative Medicine. It contains vitamin A and C. The white part of it has calcium, too. It is a good appetizer (K. P. Sampath Kumar *et al.* 2010).

Health benefits of Onion include substantial relief from number of diseases such as common cold,

asthma, bacterial infections, respiratory problems, angina, and cough. Onions are also known to repel blood thirsty insects. In other words, you may say that onions are godsend gifts. Onions are known to possess curative value from ancient time.

Hepatoprotective Activity

It was reported that *A. cepa* leaf extract also can significantly restored the elevated AST, ALT and ALP enzyme levels to the normal levels (S.F. Ige, *et al.* 2011). Recently, Riyaz Shaik *et al.* (2012) demonstrated that *A. cepa* leaves protected hepatocytes by preventing the release of these 3 enzymes. The study of B.Ogunlade *et al.*(2012) demonstrated that administration of *A. cepa* by rabbits with alcohol abuse remarkably reduced serum levels of liver biomarker enzymes. In the study, performed by K. Eswar Kumar *et al.* 2013, demonstrated that *A. cepa* aqueous bulb extract had reduced levels of AST, ALT and ALP which were elevated by ethanol administration.

Anti Tuberculosis and Antimicrobial Activity

In 2009 Chitra Shenoy *et al.* described about the preliminary phytochemical investigation and wound healing activity of *Allium cepa* Linn (Lilaceae) Renu Gupta *et al.* 2010 described that exhibited activity against MDR isolates of *M. tuberculosis* in her research entitled Anti-tuberculosis activity of selected medicinal plants against multi-drug resistant *Mycobacterium tuberculosis* isolates. Jain RC, 1993 and Ratnakar P, Murthy PS, 1996 in their study confirms that the *Allium cepa* has the anti-tubercle activity. *Allium cepa* have the anti tubercle activity as studied by Sivakumar A and Jayaraman G in 2011.

In the year 1999 a monograph was published by WHO on selected medicinal plants VOLUME 1 in which *A. cepa* is considered to have antibacterial property against tuberculosis. N. Benkeblia (2004) discussed on Antimicrobial activity of essential oil extracts of various onions (*Allium cepa*) and garlic (*Allium sativum*). Ivan A. Ross (2005) in his book Medicinal Plants of the World Volume 3 *Chemical Constituents, Traditional and Modern Medicinal Uses* describe the medicinal property of *A. cepa* for tuberculosis. Vikrant Arya (2011) in his "A Review on Anti-Tubercular Plants" describe the antibacterial property for tuberculosis, later on in 2013 Soundhari C and Rajarajan S worked *in vitro* screening of lyophilized extracts of alpinia galangal L. and *Oldenlandia umbellata* L. for anti-mycobacterial activity and described Water and ethanolic extracts of selected medicinal plants (*A. sativum* -bulb, *A. cepa* -

tissue, *S. aromaticum* -flowerbud, *C. verum* -bark) observed to have anti-TB activity for *M. tuberculosis* H37Ra by Microtiter Alamar Blue assay and confirmed to (Sivakumar A and Jayaraman G 2011). M. Muthuswamy (2013) described that *Allium cepa* and *Aloe vera* were selected to test their activity further against MDR trains of *M. tuberculosis*, while selection of *Acalypha indica* was based on its ethno-medicinal uses in respiratory disorder. *A. cepa* was selected on the basis of knowledge that *A. sativum* has anti-tuberculosis activity; therefore other species of *Allium* might also have anti- tuberculosis activity in his study of screening of anti-tubercular activity of some medicinal plants from Western Ghats of India. Water and ethanolic extracts of selected medicinal plants (*A. sativum* -bulb, *A. cepa* -tissue, *S. aromaticum* - flowerbud, *C. verum* -bark) observed to have anti-TB activity for *M. tuberculosis* H37Ra by Microtiter Alamar Blue assay (Sivakumar A and Jayaraman G 2011). Onion has the property of anti-cancer and anti-oxidant because of presence of phenols and flavonoids. It is rich in proteins, carbohydrates, sodium, potassium and phosphorous. It has been reported to be an anti-bacterial, antiviral, anti-parasitic, anti-fungal and has hypoglycemic, antithrombotic, anti-hyperlipidemic, anti-inflammatory and antioxidant activity (Parmar Namita and Rawat Mukesh, 2012).

Antioxidant Activity

Phenolic compounds are the major group contributing to the antioxidant activity of vegetables, fruit, cereals and other plant-based materials. The antioxidant activity of the compounds is partly due to one electron reduction potential that is the ability to act as hydrogen or electron donors (Chan *et al.* 2007).

The findings of the study by Siti Fairuz Che Othman *et al.*(2011) have shown that red onion (*A. cepa* L.) possesses higher Total phenolic content (TPC) than garlic (*A. sativum* L.).

Chemical Constituents of the Plant

Onions not only provide flavor, they also provide important nutrients and health-promoting phytochemicals. High in vitamin C, onions are a good source of dietary fiber, and folic acid. They also contain calcium, iron, and have a high protein quality (ratio of mg amino acid/gram protein). Onions are low in sodium and contain no fat. Onions contain quercetin, a flavonoid (one category of antioxidant compounds). Antioxidants are compounds that help delay or slow the oxidative damage to cells and tissue

of the body. Studies have indicated that quercetin helps to eliminate free radicals in the body, to inhibit low-density lipoprotein oxidation (an important reaction in the atherosclerosis and coronary heart disease), to protect and regenerate vitamin E (a powerful antioxidant), and to inactivate the harmful effects of chelate metal ions. (<http://onions-usa.org/all-about-onions/onion-health-research>[online] accessed on 20-05-2014)

Phoenix Dactylifera (Date palm)

Traditional Medicinal Application

The different parts of this plant is majorly used in conventional medicine for treatment of various disorders like memory instability, fever, pain, stammering, nervous disorders (Nadkarni K.M. 1976). Fatmah H (2013) discussed on Effect of Tempeh Dates Biscuits on Nutritional Status of Preschool Children with Tuberculosis.

Pharmacological Study

Antifungal Activity

Antifungal activity of water, acetone and methanol extracts of leaves and pits of *phoenix dactylifera* Linn. were evaluated against several pathogenic fungi by Bokhari NA *et al.* in 2012. Except water extract acetone and methanol extracts showed varying degree of growth inhibitors against *Fusarium oxysporum*, *Fusarium species* and *Fusarium solani*.

Anti-hyperlipedemic Activity

Coronary heart disease is related to decrease in the concentrations of high density lipoprotein cholesterol(HDL) and increase of low density lipoprotein cholesterol (LDL). Salah and Al miaman (2013) have reported that feedeing of defatted date seed flour containing diet at 1.5%, 2.5%, and 5.2% to rats reduced the plasma triglycerides, total cholesterol and low density liporoteins.

Anti-Ulcer Activity

Pre-treatment with date fruit ethanolic and aqueous extracts at a dose of 4 ml/kg for 14 days markedly ameliorated the ulcer index, histological indices such as necrosis, haemorrhage, congestion and oedema in stomach sections and biochemical levels of some enzymes such as gastrin in plasma and mucin and histamine in gastric mucosa of ethanol-induced gastric ulceration in rats (Al-Qarawi A, *et al.* 2005). This support to the local folk medicinal

claim that dates may be useful to humans with ulcers.

Anticancer Activity

The polysaccharides (glucans) prepared from the date fruits exhibited a dose dependant anticancer activity with an optimum activity at a dose of 1 mg/kg in tumour induced by subcutaneously transplanting allogenic solid Sarcoma-180 tumor cells into the right side of female CD1 mice. (Ishurda O, *et al.* 2005) This research validated the traditional claim of date fruits to be used against various kinds of tumors.

Anti-Diarrhoeal Activity

Aqueous extract of *Phoenix dactylifera* L at doses of 3, 6 and 12 mg/kg produced a statistically significant reduction in both castor oil induced intestinal transit and frequency of diarrhoea in rat (Abdulla Y, Al -Taher, 2008). These properties may explain the rational for the effective use of the plant as an anti-diarrhoeal agent in traditional medicine.

Effect on Gastrointestinal Transit

Water and ethanolic extracts from date flesh and date pits at doses of 0.01, 0.02 and 0.04 ml/kg showed a dose dependant increase in the gastrointestinal transit time. While water extract from dialyzed date flesh extract induced a dose-dependent decrease the gastrointestinal transit time (Al-Qarawi AA, *et al.* 2003). The possible reason for this may be the method based extraction of pirticular component which could be valuable towards respective clinical conditions.

Effect on Reproductive System

Oral administration of date palm fruit suspensions at doses of 120 and 240 mg/kg improved the sperm count, motility, morphology, and DNA quality with a concomitant increase in the weights of testis and epididymis (Bahmanpour S, *et al.* 2006). Moreover, date extracts have been shown to increase sperm count in guinea pigs and to enhance spermatogenesis and increase the concentration of testosterone, follicle stimulating hormone (FSH) and luteinizing hormone (LH) in rats (Elgasim EA *et al.* 1995). This study suggests its usefulness in solving infertility problems in males. El-Desoky and his co-workers (1995) looked into the effect of date palm pollen grains (*Phoenix dactylifera*) on sexual hormonal balance, cholesterol, total lipids, total protein, albumin, globulin, and liver functions in control male and female rats, and castrated and ovariectomized rats. Their findings showed a decline in serum

testosterone level; in control male rats, but a slight increase was detected in the castrated rats. Similarly, serum estradiol content was elevated in both control and ovariectomised rats. Progesterone level; however, decreased in control female rats, and was slightly increased in ovariectomized rats, with slight increase of serum FSH and LH in both normal and ovariectomised female rats. Pollen grains significantly increased serum globulin, total protein and total lipids in ovariectomized rats. Also serum ALP activity was increased in normal male rats. There was an increase in serum plasma glutamate pyruvate (GPT) activity in normal male, ovariectomized female and castrated rats, and similarly, glutamate oxaloacetate transaminase (GOT) activity was also increased in ovariectomized female and normal male rats. All these GPT and GOT values were still within the normal range in rats (Reshod A, Al-Shagrawi, 1998).

Nephroprotective Activity

Al-Qarawi (2008) *et al.* studied the effect of the extracts of the flesh and pits of *Phoenix dactylifera* on gentamicin induced nephrotoxicity in rats was investigated in which the significantly reduced the increase in plasma creatinine and urea concentrations induced by gentamycin nephrotoxicity and ameliorated the proximal tubular damage. Antioxidant components in the date (e.g., melatonin, vitamin E, and ascorbic acid) were suggested to be the basis of the nephroprotection. (<http://ispub.com/IJPHARM/7/1/8733>[online]accessed on 24-05-2014)

Hepatoprotective Activity

Pre and post treatment with aqueous extract of date flesh or pits significantly reduced CCl₄ induced elevation in plasma activities of aspartate aminotransferase (AST), alanine aminotransferase (ALT), Alkaline phosphatase (ALP) enzymes and bilirubin concentration and ameliorated morphological and histological liver damage in rats. This study suggests that CCl₄-induced liver damage in rats can be reversed by treatment of extracts from date flesh or pits. Moreover it can also be used prophylactically as a dynamic liver support GT (Al-Qarawi AA, *et al.* 2004), enzymes and plasma concentration of bilirubin but also exhibited an enormous increase in the reduced serum levels of testosterone, alpha fetoprotein (AFP) and glucose in the thioacetamide induced cirrhotic rats. The extracts also showed significant reduction in oxidative stress evidenced by significant rise in the hepatic

malonaldehyde (MDA) levels and decline in hepatic glutathione levels by normalising them. In another study the date flesh or pit extracts not only normalised the elevated plasma activities of AST, ALT, ALP, lactate dehydrogenase (LDH).

H.A. Abdelrahman *et al.* in 2012 also studied the protective effect of dates (*Phoenix dactylifera*) on carbon tetrachloride induced hepatotoxicity in Dogs.

Antioxidant Activity

Phytochemicals from fruits have been shown to possess significant antioxidant capacities that may be associated with lower incidence and lower mortality rates of degenerative diseases in human (Javanmardi J, *et al.* 2008).

Various *in vitro* and *in vivo* antioxidant activities have been carried out on various extracts of different parts of *Phoenix dactylifera*. Studies conducted on antioxidant activity and phenolic content of various fruits of *Phoenix dactylifera* cultivated in Iran, Algeria and Bahrain demonstrated a linear relationship between antioxidant activity and the total phenolic content (TPC) of date fruit extract (Allaith, Abdul AA, 2005). Aqueous date extract was found to inhibit significantly the lipid peroxidation and protein oxidation and also exhibited a potent superoxide and hydroxyl radical scavenging activity in a dose-dependent manner in an *in vitro* study (Dammak I *et al.* 2007). Methanolic extract of *Phoenix dactylifera* seeds showed a significant increase in plasma levels of vitamin C, E and A, β -carotene and significant decrease in the elevated MDA levels due to the lipid peroxidation in adjuvant arthritis in rats. (Mohamed DA *et al.* 2004). These findings suggests its possible use in diseases such as scurvy, ataxia and night blindness caused due to the deficiency of vitamins C, E and A respectively. Date seed oil was found to limit oxidative injuries induced by hydrogen peroxide in human skin organ culture which confirmed the potent free radical scavenging activity of the plant (Dammak I *et al.* 2007).

Studies indicate that the aqueous extracts of dates have potent antioxidant activity (Mansouri *et al.* 2005). The antioxidant activity is attributed to the wide range of phenolic compounds in dates including p-coumaric, ferulic and sinapic acids, flavonoids and procyanidins (Gu *et al.* 2003 and Al-Farsi *et al.* 2005).

Antimicrobial Activity

The anti bacterial study on *Phoenix dactylifera* carried out by Ramesa Shafi Bhat *et al.* and Saleh FA, *et al.* observed the extracts of fruit showed the

antibacterial activity against the human pathogen such as *S.aureus*, *S. pyogenes*, *B.subtillis*, *E. coli* and *P. aeruginosa* and *Staphylococcus saprophyticus* (Ramesa Shafi Bhat *et al.* 2012, Saleh FA).

Chemical Constituents of the Plant

The fruits of *Phoenix dactylifera* contain different chemical compounds such as saturated and unsaturated fatty acids, Zinc (Zn), Cadmium (Cd), Calcium (Ca), and potassium (K). Saturated fatty acids include stearic and palmitic acid and unsaturated fatty acids contain linoleic and oleic acids which could inhibit 5- α reductase enzyme (Shariati *et al.* 2008). Also, dates contain at least six vitamins including a small amount of vitamin C, and vitamins B1 (thiamine), B2 (riboflavin), nicotinic acid (niacin) and vitamin A (Al-Shahib and Marshall, 1993). Dates contain a high percentage of carbohydrate (total sugars, 44-88%), protein (2.3-5.6%), fat (0.2-9.3%), essential salts and minerals, vitamins and an elevated proportion of dietary fiber (6.4-11.5%) (El Hadrami *et al.* 2009). They also contain oil in the flesh (0.2-0.5%) and the seed (7.7-9.7%). The seed represents 5.6-14.2% of the entire fruit weight. Dates are very rich in vitamins, especially β -carotene (vitamin A), thiamine (B1), riboflavin (B2), niacin, ascorbic acid (C) and folic acid (folacin) (El Hadrami, 2009). Some of these vitamins provide 10-50% of the daily recommended intake of an adult. Ripe fruits were reported to contain a substantial amount of carotenoids including lutein and various forms of β -carotene and minor carotenoids. The contents vary with the cultivar and stage of ripeness, with the total content of carotenoids decreasing towards the final ripening stages and in storage.

Andrographis Paniculata

Traditional Medicinal Application

Andrographis paniculata is a plant that has been effectively used in traditional Asian medicines for centuries. Its perceived "blood purifying" property results in its use in diseases where blood "abnormalities" are considered causes of disease, such as skin eruptions, boils, scabies, and chronic undetermined fevers. Controlled clinical trials report its safe and effective use for reducing symptoms of uncomplicated upper respiratory tract infections. Since many of the disease conditions commonly treated with *A. paniculata* in traditional medical systems are considered self-limiting, its purported benefits need critical evaluation. (*A. paniculata* <http://altmedrev.com/publications/16/1/66.pdf> [online] accessed on 24-05-2014)

A. paniculata contains diterpenes, lactones, and flavonoids. Flavonoids mainly exist in the root, but have also been isolated from the leaves. "The aerial parts contain alkanes, ketones, and aldehydes. Although, it was initially thought that the bitter substance in the leaves was the lactone andrographolide, later investigations showed that the leaves contained two bitter principles—andrographolide and a compound named kalmeghin. Four lactones - chuanxinlian A (deoxyandrographolide), B (andrographolide), C (neoandrographolide) and D (14-deoxy-11, 12-didehydroandrographolide) - were isolated from the aerial parts in China. *A. Paniculata* contains diterpene glucoside (deoxyandrographolide- 19 β -D-glucoside) has been detected in the leaves (Weiming C, 1982) and six diterpenoids of the ent-labdane type, two diterpene glucosides and four diterpene dimers (bis-andrographolides A, B, C, and D) have been isolated from aerial parts (Matsuda T, 1994).

A. paniculata is extensively used as a hepatostimulant and hepatoprotective agent in Indian systems of medicine (Trivedi NP, *et al.* 2001). *A. paniculata* is also an ingredient in several polyherbal preparations used as hepatoprotectants in India, (Ram VJ, 2001) one of which has been reported as efficacious in chronic hepatitis B virus infection (Rajkumar JS, 2007). S.K. Mitra *et al.* (1998) described Protective effect of HD-03, a herbal formulation, against various hepatotoxic agents in rats. Rakshamani Tripathi *et al.* (2005) worked on Modulation of oxidative damage by natural products. Shahid Akbar, MD, PhD (2011) reviewed the Pharmacological Activities and Clinical Effects. G. Shivaprakash (2011) described the Evaluation of *Andrographis paniculata* leaves extract for analgesic activity. Anil Kumar (2012) worked on *Andrographis paniculata* and review on king of bitter (Kalmegh with the result *Andrographis paniculata* nees (Acanthaceae) is a medicinal plant traditionally used for the treatment of anti-inflammatory, antibacterial, antioxidant, antiparasitic, antispasmodic, antidiabetic, anti-carcinogenic, antipyretic, antidiarrhoeal, hepatoprotective, nematocidal.

Pharmacological Study

Andrographis paniculata has been reported as having antibacterial, antifungal, antiviral, choleric, hypoglycemic, hypocholesterolemic, adaptogenic, anti-inflammatory, emollient, astringent, diuretic, carminative, anthelmintic, antipyretic, gastric and liver tonic. It is also recommended for use in cases of leprosy, gonorrhoea, scabies, boils, skin eruptions,

and chronic and seasonal fevers. Juice or an infusion of fresh leaves is given to infants to relieve griping, irregular bowel habits, and loss of appetite. Leaves and root are also used in general debility, during convalescence after fevers, for dyspepsia associated with gaseous distension, and in advanced stages of dysentery. In China, the herb derived from the leaves or aerial parts of *Andrographis paniculata* is known as Chuanxinlian, Yijianxi or Lanhelian. It is described as bitter and cold, is considered to be antipyretic, detoxicant, anti-inflammatory, and detumescent, and is thought to remove "pathogenic heat" from the blood. *Andrographis paniculata* is used for the treatment of pharyngolaryngitis, diarrhea, dysentery, and cough with thick sputum, carbuncle, sores, and snake bites. Various preparations and compound formulas of the herb have been used to treat infectious and non-infectious diseases, with significant effective rates reported for conditions such as epidemic encephalitis B, suppurative otitis media, neonatal subcutaneous annular ulcer, vaginitis, cervical erosion, pelvic inflammation, herpes zoster, chicken pox, mumps, neurodermatitis, eczema, and burns. A primary modern use of *Andrographis paniculata* is for the prevention and treatment of the common cold. It appears to have antithrombotic actions, suggesting a possible benefit in cardiovascular disease. Pharmacological and clinical studies suggest the potential for beneficial effects in diseases like cancer and HIV infections.

Hepatoprotective Activity

Soumendra Darbar *et al.* (2009) described the antioxidant and hepatoprotective action of *Andrographis paniculata* by induction of hepatotoxicity in rats using single dose of Diclofenac (DIC). The results of the study concluded that the hepatoprotective effect of aqueous ethanol extract of *Andrographis paniculata* against DIC-induced acute toxicity is mediated either by preventing the decline of hepatic antioxidant status or due to its direct radical scavenging capacity.

Antimicrobial Activity

Andrographis paniculata has been extensively shows antimicrobial and antiparasitic activities such as bacteria, viruses, and parasites. Singha *et al.* (2007) reported significant antibacterial activity of an aqueous extract and attributed it to the combined effect of andrographolides and arabinogalactan proteins. A similar conclusion

was reached by Zaidan *et al.* (2005) found crude aqueous extract of leaves exhibit significant antimicrobial activity against gram positive *S. aureus*, methicillin-resistant *S. aureus* and gram-negative *Pseudomonas aeruginosa*, but had no activity against *Escherichia coli* or *Klebsiella pneumoniae*. Andrographolide, neoandrographolide, and 14-deoxy-11, 12-didehydroandrographolide are reported to be viricidal against herpes simplex virus 1 (HSV-1) without having any significant cytotoxicity at viricidal concentrations. Alcoholic extract of the rhizome was reported to possess significant *in vitro* activity against *Ascaris lumbricoides* and chloroform extract completely inhibited malarial parasitic growth within 24 hours of incubation at a concentration of 0.05 mg/mL. Same inhibition was achieved in 48 hours with methanol extract at a concentration of 2.5 mg/mL. (Anil Kumar *et al.* 2012)

Antioxidant Activity

The main and most interesting biological constituent of *A. paniculata* herb (aerial part) is a group of diterpene lactones belonging to the ent-labdane class, present in both free and glycosidic forms, and named andrographolides (Lim, J. C, *et al.* 2012). Andrographolide is the bitter principle, a colourless, neutral crystalline substance, was first isolated by Boorsma from different parts of *Andrographis paniculata*. In 1911 Gorter proved that it is structurally a lactone and named it andrographolide (in the Chinese literature it is sometimes cited as andrographis B). (María A *et al.* 2013).

The second diterpene isolated from *A. paniculata* was the minor non-bitter constituent neoandrographolide, which was first described by Kleipool in 1952. The structure of neoandrographolide was described as a diterpene glucoside and its amount in the plant is around 0.5-1%. The main preclinical effects are anti-inflammatory (Parichatikanond *et al.* 2010, Batkhuu *et al.* 2002, Liu, J *et al.* 2007), chemosensitizer, anti-herpes-simplex virus and antioxidant.

Chemical Constituents of the Plant

The plant is widely used in ayurvedic and homeopathic systems of medicines. The medicinal value of this plant is due to the presence of active ingredients *viz* andrographolide and neoandrographolide which are derivatives of diterpenoids. It prevents oxidative damage and inhibits binding to toxic metabolites to DNA.

Conclusion

Worldwide, Research and innovation are now on fast track for new bioactive compounds from herbal medicinal plants. Now the scientists targeting on specific disease like tuberculosis so as to eradicate all cases. In this direction, medicinal plants proffer a great expect to complete these desires and have been used for curing diseases for many centuries. These have been used extensively as pure compounds or as a crude material. Only a few plant species have been thoroughly investigated for their medicinal properties. India is one of the few countries in the world which has unique wealth of medicinal plants and vast traditional knowledge of use of herbal medicine for cure of various diseases. So far, few plants have been tested against mycobacteria and a few plants which showed anti-TB activity were *Salvia hypargeia*, *Euclea natalensis*, etc. The increasing incidence of MDR- and XDR-TB worldwide highlight the urgent need to search for newer anti-tuberculosis compounds/ drugs for the welfare of society and mankind.

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