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REVIEW ARTICLE

PANCHATIKTHA KWATHA CHURNAM - AN AYURVEDIC MEDICINE

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ABSTRACT

Fever is known both as a symptom and a disease. Many were affected by this without knowing its cause. Younger population to older is get affected by fever. In Ayurvedic system Fever can be correlated with jvara. The Jvara has many types caused by different doshas say Vata, Pitta and Kapha. "*Panchatiktha Kwatha Churna*" (PTKC) which is mentioned in the Hospital pharmacopeia of Arignar Anna Hospital of Indian Medicine is one of the drug indicated especially for this disease. This drug is also useful in treating skin disorders too. The aim of this paper is to explore the literary evidences of its use for both in Fever and Skin disorders in Ayurvedic system. More than 100 scientific papers were reviewed to justify the activity of the ingredients present in the PTKC. PTKC is made up of five ingredients. Further study is to be done to explore its activity scientifically and thereby standardizing the medicine.

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INTRODUCTION

Herbal drugs constitute a major part in all traditional systems of medicines. Herbal medicine is a triumph of popular therapeutic diversity. Plants above all other agents have been used for medicine from time immemorial because they have fitted the immediate personal need, easily accessible and inexpensive. 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 different (Saurabh Srivastav *et al*., 2011). Ayurveda is a complete or holistic system that integrates the mind, body and spirit. Its concept is about health and disease; promote the use of herbal compounds, special diets, and other unique health practices. Ayurvedic system of medicine is gaining its importance nowadays in treating many diseases and thereby helping the human population worldwide. *Panchatiktha kwatha churna* (PTKC) is such a poly herbal Ayurvedic medicine formulated from various medicinal plants such as stem of Guduchi (*Tinospora cardifolia)*, bark of Nimba (*Azhadirachta indica*), Kantakari - whole plant (*Solanum xanthocarpum)*, Vasa (*Adathoda vasica)* and leaves of Bhunimba (*Andrographis panniculata)*. It is prepared based on the formula mentioned in the Hospital Pharmacopeia of Arignar Anna Hospital of Indian Medicine, Arumbakkam, Chennai, India for more than three decades and used in their Ayurvedic out Patient ward in treating for intermittent fever and skin diseases. The aim of this article is to analyse the action of each ingredients and their importance in treating the diseases mentioned above.

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MATERIALS AND METHODS

Pancha Tiktha kwatha churna is collected from Ayurveda out Patient Department (OPD), Arignar Anna Hospital for Indian Medicine, Arumbakkam, Chennai, Tamilnadu, India. As per Hospital pharmacoepia *Pancha Tiktha Kwatha Churna* is prepared with equal quantities of all the five ingredients.

Guduchi

Botanical Description

Tinospora cordifolia is a large, glabrous, deciduous, climbing shrub. The stem structure is fibrous and the transverse section exhibits a yellowish wood with radially arranged wedge shaped wood bundles, containing large vessels, separated by narrow medullary rays. The bark is creamy white to grey, deeply left spirally and stem contains rosette like lenticels. The leaves are membranous and cordate in shape. Flowers are in

Table 1. Composition of PTKC

S.No.	Name of the Drug	Tamil name	Botanical Name	Part Used	Quantity
1	*Guduchi*	Seenthil	*Tinospora cardifolia*	Stem	1 part
2	*Nimba*	Vembu	*Azhadirachta indica*	Bark	1 part
3	*Kantakari*	Kandankathiri	*Solanum xanthocarpum*	Whole plant	1 part
4	*Vasa*	Adathodai	*Adathoda vasica*	Leaf	1 part
5	*Bhunimba*	Nilavembu	*Andrographis panniculata*	Leaf	1 part

Tinospora cardifolia

Azhadirachta indica

Solanum xanthocarpum

Adathoda vasica

Andrographis panniculata

Fig. 1. Ingredients of PTKC

axillary position, 2-9 cm long raceme on leaflet branches, unisexual, small and yellow in color. Male flowers are clustered and female are usually solitary. The seeds are curved. Fruits are fleshy and single seeded. Flowers grow during the summer and fruits during the winter.

Taxonomic Description

The plant *Tinospora cordifolia* comes under the class Magnoliopsida, orders Ranunculales and belongs to the Menispermaceae family. The species is widely distributed in India, extending from the Himalayas down to the southern part of peninsular India. It is also found in neighboring countries like Bangladesh, Pakistan, and Srilanka. The plant is also reported from South East Asian countries such as Malaysia, Indonesia and Thailand etc. (Abhimanyu Sharma *et al*., 2010)

Chemical Composition

A variety of constituents have been isolated from different parts of *Tinospora cordifolia*. They belong to different classes such as alkaloids, diterpenoid lactones, steroids, glycosides aliphatic compounds, polysaccharides. Some constituents have been isolated from plant mainly they are tinosporone, tinosporic acid, cordifolisides A to E, syringen, berberine, giloin, gilenin, crude giloininand, arabinogalactan polysaccharide, picrotene, bergenin, gilosterol, tinosporol, tinosporidine, sitosterol, cordifol, heptacosanol, octacosonal, tinosporide, columbin, chasmanthin, palmarin, palmatosides C and F, amritosides, cordioside, tinosponone, ecdysterone, makisterone A, hydroxyecdysone, magnoflorine, tembetarine, syringine, glucan polysaccharide, syringine apiosylglycoside, isocolumbin, palmatine, tetrahydropalmaitine, jatrorrhizine respectively (Abhimanyu Sharma *et al*., 2010).

Medicinal Property

The plant possesses anti-oxidant, anti-hyperglycemic, anti-neoplastic, anti- stress, anti- dote, anti- spasmodic, anti-pyretic, anti allergic, anti- leprotic anti- inflammatory, antihyperlypidaemia, Immunomodulatory properties. Various parts of the plant contain immense medicinal properties (Abhimanyu Sharma *et al*., 2010).

Immunomodulator Activity

Immunomodulatory activity of different fractions and extracts of stem of *Tinospora cordifolia* were evaluated using the

polymorphonuclear neutrophil (PMN) phagocytic function studies. The present study substantiates the same property of *Tinospora cordifolia* through an in vitro slide method of phagocytosis. The method is simple to perform and gives an in situ view of the internal mechanism of phagocytosis. The plant extract samples from external vendors and extracts prepared in-house were analyzed for the said property. This property of the plant can be explored to use in many disease conditions as an adjuvant therapy. Like many infectious agents are becoming resistant to currently used antibiotics, in such cases this plant based formulation can be used to enhance the immune response of the patient and bring the cells at the site of infection and increase its killing capacity. In other disease conditions like recurrent UTI infections, this immunostimulatory activity of the *T. cordifolia* will be useful to flush off the adhering infectious organisms from the mucosal surfaces by enhancing the phagocytosing activity of the cells of the immune system (Salkar *et al*., 2014).

Nimba

Botanical description

Neem (*Azadirachta indica*) is a member of the Meliaceae family and its role as health-promoting effect is attributed because it is rich source of antioxidant. It has been widely used in Chinese, Ayurvedic, and Unani medicines worldwide especially in Indian Subcontinent in the treatment and prevention of various diseases. Earlier finding confirmed that Neem and its constituents play role in the scavenging of free radical generation and prevention of disease pathogenesis. The studies based on animal model established that Neem and its chief constituents play pivotal role in anticancer management through the modulation of various molecular pathways including p53, pTEN, NF-κB, PI3K/Akt, Bcl-2, and VEGF. It is considered as safe medicinal plants and modulates the numerous biological processes without any adverse effect (Mohammad A. Alzohairy, 2016).

Biologically Active Compounds

Azadirachta indica has compound of various constituents that play role in disease management. Although more than 300 natural products have been isolated from different sections of this tree, with new compounds added to the list every year till now (Sharma *et al*., 2015), but a few of them have been studied for biological activity (Biswas *et al*., 2002). Among them some compounds are well-known for their beneficial bioactive actions like anti-inflammatory, antifungal, antibacterial etc. as shown in Table 2.

Table 2. Some bioactive compounds from Neem

Neem compound	Source	Biological activity
Gallic acid, epicatechin and catechin	Bark	Anti-inflammatory, Immunomodulatory
Polysaccharides GIa , GIb	Bark	Anti-tumour

Antibacterial Properties

Werner Fabry *et al*. (1998) in their study reported that extracts of stem bark and leaves of *Azadirachta indica* showed the minimum inhibitory concentration (Staphylococcus, Enterococcus, Pseudomonas, Escherichia, Klebsiella, Salmonella, and Mycobacterium). Methanolic and acetone extracts of A. indica were more effective against the bacteria compared to that of aqueous extract (Singh *et al*., 2016). Studies at molecular level demonstrate that A. indica contains chemical constituents of alkaloids, terpenoids tannins and flavonoids. These chemicals might show the antibacterial activity having the ability to make a complex with the bacterial cell walls. Inhibitory activity towards DNA topoisomerase enzyme II by azadiractin, a bioactive metabolite of Neem might also involve in the antibacterial potential. Moreover, the Gram positive bacterial strains were found more sensitive than the Gram-negative ones (Sinaga *et al*., 2016).

Determination of Analgesic Activity

The crude extracts of *Azhadirachta indica* showed significant analgesic action compared to the reference drug indomethacin. Pain sensation in acetic acid induced writhing method is elicited by triggering localized inflammatory response resulting release of free arachidonic acid from tissue phospholipid via cyclooxygenase (COX), and prostaglandin biosynthesis (Dinda *et al*., 2013).

Determination of Preliminary phytochemical analysis

The preliminary phytochemical analysis showed that the hydro-alcoholic extract of *Azadirachta indica* leaf revealed the presence of alkaloids, triterpenoids, tannins and flavonoids. The flavonoids are known to possess Anti-inflammatory activity by inhibiting the cyclooxygenase responsible for synthesis of inflammatory prostaglandins (Dinda *et al*., 2013).

Carrageenan induced rat paw oedema

The methanol extract of *Azhadirachta indica* was investigated for its anti-inflammatory and analgesic activities in animal models. The hydro-alcoholic extract, ethyl acetae and n-butanol fractions at 100 mg/kg body weight reduced significantly the formation of oedema induced by carrageenan. The results were also comparable to those of indomethacin, the reference drug used in this study (Perianayagam *et al*., 2006).

Kantakari

Solanum xanthocarpum is commonly known as the Indian night shade or Yellow berried night shade (English). It is a prickly diffuse, bright green perennial herb, woody at the base, 2–3 m height, found throughout India, mostly in dry places as a weed along roadsides and waste lands. *Solanum xanthocarpum* is known by different name in various different languages in India viz, Kantkari (Sanskrit), Kateri (Hindi), Bhoringni (Gujarati), Kantankattiri (Tamil), Kantkariccunta (Malayalam), Vakudu (Telugu), Nelagulle (Kannad). In ancients Ayurveda, plant is described as pungent, bitter, digestive, alternative astringent. Stems, flowers, fruits are bitter, carminative. Root decoction used as febrifuge, effective diuretic and expectorant. Charaka and Sushruta used the extract of entire plant and fruits in internal prescription for bronchial asthma, tympanitis, misperistalsis, piles and dysuria and for rejuvenation (Sachin Parmar *et al*., 2010). *Solanum xanthocarpum* is an important source of many pharmacologically and medicinally important chemicals, particularly steroidal hormone solasodine and other chemicals like solasonine, campestrol, campeferol, diosgenin and various useful alkaloids. Solanum xanthocarpum safe for human use and is regarded as a valuable plant in both Ayurvedic and modern drug development areas for its versatile

medicinal uses. The plant is widely studied for the various pharmacological activities like antiasthmatic, hepatoprotective, cardiovascular, hypoglycemic and mosquito repellent properties (Reddy and Rajasekhar Reddy, 2014).

Chemical Constituents

Solanum xanthocarpum plant contains alkaloids, sterols, saponins, flavonoids and their glycosides and also carbohydrates, fatty acids, amino acids etc (Ghani, 1998).

Hepatoprotective activity

In Chandana *et al*. investigated *Solanum xanthocarpum* extracts for hepatoprotective activity using CCl4 induced hepatotoxicity in rats. Rats administered with CCl4 but treated with *Solanum xanthocarpum* extracts showed significant increased in the level of enzyme which indicates the antioxidant activity of *Solanum xanthocarpum*. Jigrine is a polypharmaceutical herbal formulation containing aqueous extracts of 14 medicinal plants including *Solanum xanthocarpum* and used for liver ailments (Chandana *et al*., 2011). Najmi *et al*. investigated the DPPH-free radical scavenging activity, hepatoprotective and antioxidant activity of Jigrine against galactosamine induced hepatotoxicity in rats (Najmi *et al*., 2005).

Antiasthmatic activity

A pilot study on the clinical efficacy of *Solanum xanthocarpum* and *Solanum trilobatum* in bronchial asthma proves the significant use of herbs in the treatment of asthma (Mohan *et al*., 2007). Major literature data supports use of whole plants. Gautam *et al* 2008 evaluated the therapeutic effect of ethanolic extract of *Solanum xanthocarpum* i.e. asthma relieving or antihistaminic, antiallergic property. Gautam *et al*. 2008 studied effects of *Solanum xanthocarpum* extract on some of the parameters like smooth muscle relaxation, and antagonism of asthma mediators such as histamine, eiosinophils and protection against mast cell degranulation which seemed to be prominent in pathophysiology of asthma (Vadnere *et al*., 2008).

Anti-inflammation activity

Stigmasterol, carpesterol and diosgenin showed Antiinflammation Effect (Gabay *et al*., 2010; Bhattacharya *et al*., 1980). Lupeol in Solanum xanthocarpum also acted as multi-target agent with immense anti-inflammatory potential, targeting key molecular pathways. Lupeol at its effective therapeutic doses exhibited no toxicity to normal cells and tissues. Hence, it may serve as atherapeutic and chemopreventive agent for treatment of inflammation (Saleem and Lupeol, 2009).

Vasa

Vasa, botanically identified as a *Adhatoda vasica* Nees., belonging to Acanthaceae family is important Ayurvedic medicinal herb. It is an evergreen, gregarious, stiff, perennial shrub, 1.2-6.0 m in height, distributed throughout India, up to an altitude of 1,300m^2. Leaves of *Adathoda vasica* are ellipticlanceolate or ovate-lanceolate, entire, 5-30 cm long, hairy, light green above, dark below, leathery; flowers are large, white with red- or yellow-barred throats, in spikes with large bracts; capsules are clavate, longitudinally channeled, 1.9-2.2 cm× 0.8 cm and seeds are globular (Anonymous: The Wealth of India (Raw materials), 2005). Its leaves are extensively used for treating cold, cough, whooping cough and chronic bronchitis and asthma as sedative expectorant, antispasmodic and anti-inflammatory drug.

Properties and Actions according To Ayurveda

Rasa (taste): Tikta (Bitter), Kashaya (Astringent) Guana (quality): Laghu (light) Virya (Potency): Sheeta (cold) Vipaka (post digestive effect): Katu / Laghu Karma: Hridya, Kaphapittahara, Raktasangrahika, Kasaghna (Anonymous: the Ayurvedic Pharmacopeia of India, Part-1, 2004).

Major chemical constituents

The Leaves have been found to be a rich source of alkaloids of which vasicine and vasicinone are bioactive. A non-nitrogenous neutral principle, vasakin, vasicinone, two new quinazoline alkaloids, one of which was named as adhvasinone and two new pyrroloquinazoline alkaloids, desmethoxyaniflorine and 7-methoxyvasicinone were identified from the ethanolic extract of the leaves (Anonymous: Review on Indian medicinal plants, 2004).

Experimental Pharmacology

Expectorant - The petroleum ether extract of the leaves 50mg/kg bw i.p. and i.v. (Inamdar *et al*., 1960)

Bronchodilator - Vasicinone isolated from the leaves had a bronchodilator action (Amin and Mehta, 1959). Vasicine showed bronchodilator activity in both in vivo and in vitro experimental studies (Gupta *et al*., 1977).

Antitussive - The plant extract was evaluated in experimental models for antitussive activity (Dhuley, 1999).

Anti tubercular activity - It was found that bromhexine and ambroxol, the semi-synthetic derivatives of vasicine have activity against Mycobacterium tuberculosis in vitro (Grange and Snell, 1996).

Platelet activity - vasicine hydrochloride –alkaloid from leaves (Atal *et al*., 1982).

Enzyme activity - The decoction of the leaves of the plant activated the trypsin enzyme (Bhargav *et al*., 1988).

Anti-inflammatory activity - 50% ethanolic extract of the plant (excluding root) (Vijaya and Vasudevan, 1994).

Antimicrobial activity - The alcoholic extracts of the leaves and root of Vasa showed antibacterial activity against Staphylococcus aureus and Escherichia coli. The water extract of the leaves also showed activity against Staphylococcus aureus (Bhakuni *et al*., 1990).

Antiviral activity - The crude extract of the leaf, the bark and the plant (Kalpesh Panara *et al*., 2014).

Anthelmintic activity - The leaves (oil) as well as the alkaloids, vasicine and vasicinone were screened against Ascaris lumbaricoides neuromuscular preparations (Singh, 1972).

Hepatoprotective activity - Biologically active phytoconstituents such as Alkaloids-Quinazoline, Flavonoids, Tannins, Vasicinone, Essential oil which are present in the various extracts of Adhatoda vasica are accountable for the significant hepatoprotective activity (Bhaduri *et al*., 1985).

Pharmacokinetic Properties

Vasicine - Accumulation of the drug in other smooth and skeletal muscles was noticed 90 min after administration. There was no appreciable accumulation of the drug in the liver (Zutshi *et al*., 1980). The in vivo metabolism of vasicine on oral administration in rats revealed, that the process of metabolism was very fast and first pass effect was appreciably pronounced and this might be the cause of loss of efficacy of vasicine as an abortifacient when administered orally (Sharma *et al*., 1983). Ram *et al*. (2007) determined the site of absorption of vasicine in the intestine. They used everted sac method to assess the absorption. Duodenum was reported to have the maximum capacity to absorb isolated vasicine from the methanolic and ethanolic extracts of Vasaka (Ram and Shirwaikar, 2007). Pharmacokinetics studies of vasicine were conducted. The peak plasma concentration was detected in the plasma (Amla *et al*., 1987).

Bhunimba

Andrographis paniculata (Burm.f.) Wall. ex Nees., (FamilyAcanthaceae) (English name-King of Bitters, Tamil name-Nilavempu) is an annual herbaceous plant and is extensively cultivated in Southern Asia, China and some parts of Europe. In traditional medicine, A. paniculata is widely used to get rid of body heat, dispel toxins from the body; prevent common cold, upper respiratory tract infections including sinusitis and fever and as an antidote against poisons of snakes and insects. The plant has been reported to exhibit various mode of biological activities in vivo as well as in vitro viz., antibacterial, antiviral, anti-inflammatory, anti HIV (Human immunodeficiency virus), immunomodulating/ immunostimulatory and anticancer. The plant showed potential therapeutic action in curing liver disorders, common cough and colds in human. The characteristic secondary metabolites encountered in this plant have considerably enhanced its importance in the arena of medicinal plants (Joseph Joselin and Solomon Jeeva, 2014).

Botanical description

Andrographis paniculata is an annual, branched, herbaceous plant erecting to a height of 30-110 cm in moist shady places. The stem is acutely quadrangular; much branched and can be broken easily due to its fragile texture. Leaves are simple, opposite, glabrous, lanceolate, 2-12 cm long, 1-3 cm wide with acute entire margin. Inflorescence is terminal and axillary in panicle, 10-30 mm long with small bract and short pedicel. The flowers possess calyx with 5 sepals which are small and linear. Corolla tubes are narrow, about 6 mm long, bilabiate, upper lip oblong, white with a yellowish top, whereas the lower tips are broadly cuneate, 3-lobed, white with violet markings. Stamens 2, inserted in the throat, anther basally bearded. Ovary superior, 2-celled with exerted style. Capsule of the herb is erect, linear-oblong, 1-2 cm long, compressed, longitudinally furrowed on broad faces with thin glandular hairs. Seeds are very small (Niranjan *et al*., 2010; Zhang, 2004). In Traditional Chinese Medicine, *Andrographis paniculata* is a bitter and 'cold property' herb. It is used in the treatment of 'hot' conditions such as acute infections and fever, including throat infection, pneumonia, tonsillitis, dysentery, gastroenteritis and pyelonephritis (The promotion and development of traditional medicine: report of a WHO meeting, 1978; Deng *et al*., 1982; Bensky and Gamble, 1993).

Pharmacognosy

The presence of important phytochemicals in *A. paniculata* make the plant useful for treating different ailments and have a potential of providing useful drugs of human use. The quantitative determination of pharmacognostic parameters will help for setting standards for crude drugs (Sharma *et al*., 2012; Sivananthan and Elamaran, 2013).

Antibacterial activity

The development of bacterial resistance to currently available antibiotics has made it necessary to search for new antibacterial agents. New sources, especially natural products from plants, are being investigated because medicinal plants have been widely used for treatment of many types of acute and chronic diseases and many plants with antimicrobial activity have been reported (Dharmadasa *et al*., 2013). Within the recent years, infections have increased to a great extent and antibiotics resistance effects become an ever-increasing therapeutic problem (Cowan, 1999). Natural products of higher plants may possess a new source of antimicrobial agents with possibly novel mechanisms of action (Mahesh and Satish, 2008; Ahmad and Aqil, 2007). They are effective in the treatment of infectious diseases while simultaneously mitigating many of the side effects that are often associated with synthetic antimicrobials (Barbour *et al*., 2004). Abubacker and Vasantha (Abubacker and Vasantha, 2010) studied the antibacterial effect of ethanolic leaf extract of *A. paniculata* against Escherichia coli; Klebsiella pneumonia, Proteus vulgaris and Streptococcus pneumonia by disc diffusion method were identified. The results revealed that the ethanolic leaf extract and andrographolide compound isolated from the leaves are potent in inhibiting these bacteria and the work highlights that the inhibitory effect is on par with standard antibiotics.

Effect on inflammation and fever

Andrographis paniculata is used as a folk medicine for reducing inflammation. Three ingredients deoxyandrographolide, Andrographolide and neoandrographolide are effective in reducing inflammation (Dutta and Sukul, 1982). In other studies it was found that *Andrographis paniculata* extracted with alcohol (Sawasdimongkol *et al*., 1990; Chantasutra and Limpapanichkul, 1989), *A. paniculata* extracted with water (Sawasdimongkol *et al*., 1990) and *A. paniculata* extracted with chloroform (Chantasutra and Limpapanichkul, 1989) reduced inflammation. Madav *et al* found that Andrographolide significantly inhibited carrageenin-, kaolin-and nystatin18 induced paw oedema (different models of inflammation) in rats (Madav *et al*., 1996). In China, it has been reported that Andrographolide has some beneficial effects as an antiinflammatory agent (Radhika *et al*., 2009; Shen *et al*., 2000), whereas Deng *et al*. who studied on rats and mice concluded that four lactones from A. paniculata have anti-inflammatory and anti-pyretic effects (The promotion and development of traditional medicine: report of a WHO meeting, 1978).

Anti-inflammatory activity

Shen *et al*. (Prakash *et al*., 2011) have established that the anti-inflammatory effect of Andrographolide could be explained by its ability to inhibit neutrophil adhesion/transmigration through suppression of Mac-1 upregulation. Andrographolide may be useful for the improvement of inflammatory disorders by limiting the early phases of neutrophil infiltration. Iruretagoyena *et al*. showed that andrographolide is able to down modulate both humoral and cellular adaptive immune responses. This molecule when used in vitro, was able to interfere with T cell proliferation and cytokine release in response to allogenic stimulation. Treatment with andrographolide was able to significantly reduce EAE symptoms in mice by inhibiting T cell and antibody responses directed to myelin antigens. Their data suggest that andrographolide is able to efficiently block T cell activation in vitro, as well as in vivo, a feature that could be useful for interfering with detrimental T cell responses (Shen *et al*., 2002).

Anti Cancer Activity

Tan *et al*. utilized the well-characterized epidermal growth factor receptor (EGFR) and transferrin receptor (TfR) expressed in epidermoid carcinoma (A-431) cells as a model to study the effect of andrographolide on receptor trafficking. Andrographolide treatment inhibited cell growth, down-regulated EGFRs on the cell surface and affected the degradation of EGFRs and TfRs. This study sheds light on how andrographolide may affect receptor trafficking by inhibiting receptor movement from the late endosomes to lysosomes. The down-regulation of EGFR from the cell surface also indicates a new mechanism by which andrographolide may induce cancer cell death (Wang *et al*., 2007). The results demonstrate for the first time that 14-DAG desensitizes hepatocytes to TNF-a-mediated apoptosis through the release of TNFRSF1A. This can be used as a strategy against cytokine-mediated hepatocyte apoptosis in liver dysfunctions (Tan *et al*., 2010).

Antiviral and Antifungal effects

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 (Dua *et al*., 2009). Fungal infections are one of the major health problems in tropical countries. Fungi or dermatophytes invade in to the keratinophilic region of the body and cause dermatophytosis. Radha *et al*. examined the petroleum ether, acetone, chloroform and methanolic extracts of *Andrographis paniculata* leaves and stems, in order to evaluate the antifungal potential of Candida albicans and Aspergillus flavus (Manjusha *et al*., 2011). Similar studies were conducted by Bobbarala *et al*. against Acremonium strictum, Alternaria alternata, Aspergillus flavus, Bipolaris bicolor, Cladosporium herbarum, Curvularia lunata, Fusarium oxysporum, Penicillium expansum, Rhizoctonia solani, Tiarosporella phaseolina and Ustilago maydis using hexane, chloroform and methanolic extracts and the results revealed that the methanolic extract showed activity against Alternaria alternate whereas, the chloroform extracts showed greater activity against Fusarium oxysporum (Aniel Kumar *et al*., 2010).

Immunomodulatory activity

Intra-gastric administration of ethanol extracts of the stems and leaves, andrographolides to mice was reported to stimulate antibody production and the delayed-type hypersensitivity response to sheep red blood cells (Puri *et al*., 1993). The extract and purified andrographolide was also reported to stimulate an innate immune response in mice, measured by macrophage migration index, phagocytosis of [14C] leucinelabelled E.coli, and proliferation of splenic lymphocytes stimulated with *Andrographis paniculata* extract (Panossian *et al*., 2002). However, the mechanism of the immunostimulation of andrographolide was not investigated. Andrographolide has been reported to have both immuno-stimulant and suppressant activities (Panossian *et al*., 2002). Rajagopal *et al* and Kumar *et al*. reported the immunostimulatory activity of andrographolide in vitro in PHA stimulated HPBLs (human peripheral blood lymphocytes) by increased proliferation of lymphocytes and production of IL-2 (Maunwongyathi, 1994; Sirisha Mulukuri *et al*., 2011).

Conclusion

From the vast literature study and experimental results analysis, it can be concluded that the ingredients present in the PTKC is capable of treating intermittent fever either caused by bacteria or virus. Also most of the ingredients of PTKC are having immunomodulatory action hence PTKC can be used in skin diseases too. Though biological activities and toxicological studies have been done for *Guduchi*, *Nimba*, *Kantakari*, *Bhunimba* and *Vasa*, Pharmacological reviews on above mentioned plant will give valuable information which will assist the Ayurveda physician in getting more advanced knowledge about the scientific activities of ingredients of PTKC. Further clinical trials should be carried out to develop the scientific evidence for the uses of PTKC in treating fevers and skin diseases.

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