

We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,900

Open access books available

186,000

International authors and editors

200M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com



Antiviral Plant Extracts

*Ganesh Kumar Anbazhagan, Sankarganesh Palaniyandi
and Baby Joseph*

Abstract

Herbal therapy has been an important part of health and wellness for hundreds of years. The renewed interest in medicinal plants has focused on herbal cures among indigenous populations around the world. Recent surveys have indicated that worldwide people now make more visits to healthcare professionals who specialize in alternative medicine than to doctors who practice conventional medicine. It is hoped that extracts from herbs will add new medicinal plants to the world's pharmacopoeia before they are lost forever that too particularly against viral infection. Based on the ethnobotanical data and the information collected from Siddha/Ayurvedic practitioners of India, extracts obtained from *Boerhavia diffusa*, *Eclipta alba* and *Phyllanthus amarus* will be having great potential in curing various viral infections.

Keywords: antiviral, herbs, *Boerhavia diffusa*, *Eclipta alba*, *Phyllanthus amarus*

1. Introduction

For hundreds of years, herbal therapy has played a major role in maintaining the health and wealth of people around the world. For treatment of various illnesses, herbs are widely used. In most of the developing countries, nowadays, people prefer alternative medicine than conventional medicine indicated by a recent survey. Many publications and books claim the proficiency of herbs for the treatment of various illnesses including cirrhosis, hepatitis, and other deadly diseases. It has been observed widely that the medicinal plants and traditional medicines are used as a normative basis for maintaining good health [1].

In the process of developing many drugs, an increasing demand for the use of medicinal plant-derived products in the industries has been found [2]. For personal health maintenance, herbal remedies have become more popular in treatment of minor ailments. Due to increasing demand, there is a great risk that the existing medicinal plants on earth might disappear. Thus an important component of the health care system in a country like India is medicinal plants.

Chemical compounds obtained from plant source are termed as secondary plant products. Alkaloids and glycosides are the two major compounds present. In 4000 plant species, more than 3000 alkaloids have been identified. The difference between a toxic and medicinal effect of many alkaloids depends upon the dosage. When a sugar molecule gets attached to component which is active, it is called as glycoside which is categorized by the nature of the active component or nonsugar.

Clinical research of the present era has confirmed the ability of many medicinal plants in treating various viral diseases, while many recent scientific research have

discovered the exact mechanism by which many different plants provide their therapeutic advantages. Three such plants are *Boerhavia diffusa*, *Eclipta alba* and *Phyllanthus amarus*.

2. Boerhavia diffusa

Boerhavia diffusa is a herbaceous plant commonly known as punarnava in Sanskrit. The whole plant is known to have medicinal properties and being used in most parts of the subcontinent. Alkaloids are best known principle product present in the roots which is known as punarnavine. In traditional medicine, *Boerhavia diffusa* is more commonly used in the treatment of jaundice, dyspepsia, abdominal pain, spleen enlargement and as an antistress agent. In the year 1980–1991, researchers proved that *B. diffusa* root extract had strong antihepatotoxic properties which can be used to cure viral hepatitis [3].

2.1 Origin and distribution

B. diffusa is found mostly in Asia, that too in warmer parts with an altitude of 2000. It grows well in crop fields and wastelands after the rainy season [4]. The genus *Boerhavia* has many species, and is also found spread in few regions of the world. *B. diffusa* is found in few places of Australia, South Africa and USA apart from Asian countries like China, Egypt, Pakistan, Sudan, Sri Lanka and in several countries of the Middle East [5]. Out of the 40 species of this genus, 6 species are found in India namely *B. diffusa*, *B. chinensis*, *B. erecta*, *B. repens*, *B. rependa* and *B. rubicunda* [6].

Taxonomy

Kingdom	-	Plant Kingdom
Class	-	Dicotyledons
Sub class	-	Monochlamydeae
Series	-	Curvembryae
Order	-	Caryophyllales
Family	-	Nyctaginaceae
Genus	-	<i>Boerhavia</i>
Species	-	<i>diffusa</i>
Binomial name	-	<i>Boerhavia diffusa</i>
Floral formula		
Br, Brl, O, [+], P5, A[5], G[2]		

2.2 Chemical constituents

The main component 2-glucopyranose-4-hydroxy-5-[P-hydroxyphenyl]-propionyl diphenyl methane was found in the roots of the plant. Many steroids, triterpenoids, alkaloids, flavonoids, lipids, lignins, proteins, carbohydrates and glycoproteins are mostly found [7]. Punarnavine, hypoxanthine 9-L-arabinofuranoside, ursolic acid, boeravinone, punarnavoside and liiroden-drin have been purified and elucidated in detail for their biological activity with antiviral properties. Large amount of potassium nitrate is mostly found in this plant. The entire plant has huge percentage of proteins and fats. It also contains 14 amino acids in root, out of which 7 are essential amino acids. Punarnavoside is an antifibrinolytic compound isolated from the roots of *B. diffusa* long back [8]. When roots were analyzed for phytochemical screening, maximum alkaloid content [2%] was found.

2.3 Pharmacology

Pharmacological studies have demonstrated strong antiviral properties. Wide diuretic properties have been found in punarnavoside obtained from Punarnava, apart from that anthelmintic, antifibrinolytic, anticonvulsant, antibacterial, antihepatotoxic, antiasthmatic and antinematodal activity have also been observed. Against various abnormal production of liver enzymes AST, ALT and pigment bilirubin, the aqueous root extracts of *B. diffusa* at a dose of 2 ml/kg exhibited strong protection [9].

Drugs obtained from this herb, given either alone or in combination with other drugs were found to be effective in killing many virus for disorders pertaining to liver, infections of the respiratory tract and heart disease [10]. Against various bacteria, the purified form of glycoprotein obtained from *B. diffusa* exhibited strong antimicrobial activity. Many clinical researches have proved that against bacteriophages punarnava is found to be very effective [11]. For inducing systemic resistance in various crops against different viruses, the roots of *B. diffusa* are used [12].

2.4 Antiviral activity of *Boerhavia diffusa*

Against potato virus X, *Boerhavia diffusa* have shown a very good effect in inhibiting in hypersensitive and systemic hosts. The inhibition of these extracts was found to be very sensitive to actinomycin D. By the application of the aqueous root extract of *B. diffusa*, the destructive yellow mosaic disease of mung bean [*Vigna radiata*], caused by mung bean yellow mosaic virus was controlled. The treatment also resulted in increased plant height, root nodulation, primary and secondary branches, grain yield and pod formation. Against bacteriophage, the purified form of glycoprotein obtained from *Boerhavia diffusa* showed strong antimicrobial activity. To resist viral infection in many susceptible crops, the extracts obtained from the roots of *B. diffusa* was used. This antiviral agent was active against *Nicotiana tabacum*, Sunhemp and *Crotalaria juncea* [13].

3. *Eclipta alba*

Eclipta alba grows as a weed commonly in wet places around the world. It is widely distributed in India, China, Thailand and Brazil. *Eclipta alba* [L.] Hassk. [syn. *Eclipta prostrata* L.], commonly known as False Daisy is a plant from the family Asteraceae. Different varieties of indigenous drugs possessing analgesic properties have been obtained from this plant in Ayurveda. Extract of *E. alba* showed strong analgesic properties [14].

3.1 Origin and distribution

In the tropical and subtropical regions of the earth. *Eclipta alba* is usually found on poorly drained wet areas, on the dikes of rice paddies, along streams and ditches in marshes. It is most commonly found in elevated lands with 1200 mm of rainfall or more. It grows very well in salty and humid conditions but is mostly a plantation crop [15]. In few countries, it is found near sea level and is said to be a naturalized weed in waste places, open fields often near ditches and in cultivated areas [16]. In some parts of the world, it is a common plant of foreshores, stream-sides, wet situations, weed of wet pasture and in roadside ditches. In is also found in low altitudes [17].

Taxonomy

Kingdom	-	Plantae
Division	-	Magnoliophyta
Class	-	Magnoliopsida
Order	-	Asterales
Family	-	Asteraceae
Genus	-	<i>Eclipta</i>
Specie	-	<i>alba</i>
Binomial name	-	<i>Eclipta alba</i>
Floral formula		
Br, Brl, O, %, K α , C[5], A[5], G[2]		

3.2 Chemical constituents

In the year 1991, a new aldehyde was isolated from this plant. The leaves of this plant contain α -terthienyl methanol, 2-formyl-terthienyl, stigmasterol, de-me-wedelolactone 7-O-glucosides and wedelolactone [18]. Aerial parts of the plant contain β -amyrin, wedelolactone, phytosterol A, luteolin-7-glucoside and its glucosides [19].

3.3 Pharmacology

In Ayurveda and in traditional Chinese herbal medicine, this species is widely used. It is used as liver tonic, rejuvenative and also widely used for better growth of hair [20]. The whole plant is used as ophthalmic, purgative, astringent, deobstruent, depurative, emetic, febrifuge, tonic and styptic. It is used internally for the treatment of anemia and diphtheria, dropsy and liver complaints [21], tinnitus, premature greying of the hair and tooth loss. It is also widely used for many external applications like oil for hair loss, dermatitis, wounds and even for athlete's foot [22]. For treating scorpion stings, its leaves are used. The plant juice is widely used for catarrhal problems and for those having increased production of bilirubin.

At the time of flowering, this plant is mostly harvested and is dried for further use. The roots are purgative and emetic. In cattle, it act as antiseptic to cure ulcers and wounds. In Ayurvedic medicine, the leaves of this plant are used a liver tonic. The dye produced from *E. alba* is most widely used for the purpose of tattooing [23].

To treat eczema and dermatitis, *E. alba* is widely used. In China and Brazil, it is also used as antivenom against snakebite. To reduce the inflammation of spleen and liver on few occasions, *E. alba* was used and found to be effective. Antiviral activity particularly in inhibiting Ranikhet disease virus, the alcoholic extract of the plant was proved to be very effective. To promote bile flow and protect the parenchyma, it is commonly used in viral hepatitis. This plant was widely used for antiaging too. In case of debility, the tonic obtained particularly from *Eclipta alba* is used. For minor cuts, burns and for inflammation, it is used externally. In children with upper respiratory, eye and ear infection, the leaf juice is mixed with honey. In the treatment of cirrhosis of the liver and infectious hepatitis, *E. alba* is used in the phytopharmaceutical formulations of medicines [24]. For rattlesnake bite, wedelolactone obtained from this plant is used. The shoot extract shows antimicrobial activity against Gram-positive bacteria *Staphylococcus aureus* and Gram-negative bacteria *Escherichia coli*.

3.4 Antiviral activity of *Eclipta alba*

Against many viruses, the extracts of *Eclipta alba* were proved to have strong antiviral activity [25]. Though the fresh juice of leaves is used for various benefits

like increasing appetite, mild bowel regulator, it is mainly used in viruses causing blood borne hepatitis. It is also used to protect the parenchyma and to promote bile flow which is popularly used to enhance learning and memory. In most parts of the subcontinent, it is used for jaundice, as a deobstruent and cholagogue in hepatic injury and other ailments of liver. One of the most potent inhibitory activity against HIV-1 integrase [HIV-1 IN] was found in the water extract of *Eclipta prostrata* [26].

4. *Phyllanthus amarus*

In Ayurveda, *Phyllanthus amarus* is an Indian herb that has been used in support liver. ‘Phyllanthus’ is also represented by the name “leaf and flower” as the fruit and the flower are found under the leaf [27].

4.1 Origin and distribution

In all tropical regions of the planet, *P. amarus* is widely distributed. The exact geographic origin of this plant was not found by Paleobotanical studies [28, 29]. This plant may be indigenous to the tropical Americas and also to the Philippines or India [22].

Taxonomy		
Kingdom	-	Plantae
Division	-	Angiospermae
Class	-	Dicotyledoneae
Order	-	Tubiflorae
Family	-	Euphorbiaceae
Genus	-	<i>Phyllanthus</i>
Species	-	<i>amarus</i>
Binomial name	-	<i>Phyllanthus amarus</i>
Floral formula		
Br, Eb1, p[5], A5 G[3]		

4.2 Chemical constituents

Some of the secondary metabolites that are present in *P. amarus* include lignins alkaloids, hydrolysable tannins, flavanoids, and polyphenols. Such phytochemicals and their structure were usually determined by using IR, UV, NMR and mass spectroscopy [30]. Apart from that, preparative thin layer chromatography and column chromatography are also used by which few new alkaloids were isolated [31].

4.3 Pharmacology

Parts of this plant *P. amarus*, mostly fresh and occasionally dry are sold and the decoctions are used widely for herbal baths. To treat bladder and kidney disorders, herbal decoction of this plant is used in traditional medicine [32]. This herb can also be used as tonic and can also be used as an appetizer. *P. amarus* plant extracts is also used as blood purifiers. It also helps to release phlegm for light malaria fevers and anemia [33]. In combination with many other herbs, this herb is used for curing flu, asthma and fever. The leaves are boiled and used to treat dysentery and even skin disorders [34]. For constipation also, studies have proved that extracts are very effective. Apart from that, extracts have even shown anti-cancer properties. It also has beneficial effects on liver functions.

Several studies in the past have proved that *P. amarus* inhibits the activity of the HBsAg [35]. Widespread studies on *P. amarus* have showed that the extracts possess strong antiviral activities particularly against HBV and HCV. In Indian system of medicine, a chemo-biological fingerprinting methodology for standardization of *P. amarus* preparation was even patented [36].

4.4 Antiviral activity of *Phyllanthus amarus*

Evaluation of antiviral activity of *Phyllanthus* species was evident from aqueous extract showing strong activity against viruses like HSV1 and HSV2 in vero cells by quantitative polymerase chain reaction. To study protein expressions of treated and untreated infected vero cells, western blot and 2D-gel electrophoresis were most widely used. *Phyllanthus amarus* along with *Phyllanthus urinaria* demonstrate the strongest antiviral activity against both HSV1 and HSV2 viruses which is proposed to its action in the early stage of replication and infection [37].

In conclusion, in the existing scenario, there is an essential need for the development of new antiviral drugs. As on date there are many epidemiological studies that have evaluated different targets of these antivirals and promising results were obtained. Still a lot of research is needed to find out the actual potential for human use.

Ethnobotanical information				
Plant	Parts used	Benefits	Information obtained from	Reference
<i>Eclipta alba</i>	Roots	In the treatment of piles. Root paste is used to cure bloody dysentery. It is also used for leukorrhea, rheumatism and stomach ache. The root juice is used in treating asthma, scanty urine and internal inflammation disorders.	India	Mitra and Gupta [38]
	Flowers, leaf and roots	Remedy for catarrh in infants, toothache, headache and roots are emetic and purgative	India	Puri [39]
	Entire plant	Remedy for the treatment of bleeding, hemoptysis, hematuria and itching, hepatitis, diphtheria and diarrhea	Taiwan	
<i>Phyllanthus amarus</i>	Entire plant	As a cooling and restorative herb, which supports the mind, nerves, liver and eyes	China	
	Aerial parts of the plant	Used in the treatment of liver, kidney and bladder problems. Also used for diabetes and intestinal parasites	Many parts of the world	Chevallier [22]
	Entire plant	Kidney stones	Spain	Houghton et al. [31]
	Entire plant	Used to eliminate gall bladder and kidney stones, and to treat gall bladder infections	South America	
	Entire plant	Used in traditional medicine to treat liver diseases, asthma and bronchial infections	India	Foo [30]

In comparison to synthetic counterparts, extracts obtained from *Boerhavia diffusa*, *Eclipta alba* and *Phyllanthus amarus* are tend to be safer, very effective and cheap. The extracts obtained from these plants might have compounds that are true antiviral, but are present at insufficient quantity to inactivate all infectious virus particles. It is very much possible that obtaining active constituents from these plants will be providing many useful leads in the development of effective antiviral agents. Thus there is an urgent need to find effective antiviral agents as the existing drugs may be effective but in a specific manner. Based on the existing knowledge of traditional medicine, these three plants have to be explored further for formulating effective drugs against various dreadful disease caused by viruses.

Author details

Ganesh Kumar Anbazhagan^{1*}, Sankarganesh Palaniyandi^{1,2*} and Baby Joseph²

1 Department of Microbiology, Hindustan College of Arts and Science, Chennai, India

2 Centre for Research and Consultancy, Department of Food Technology, Hindustan Institute of Technology and Science, Padur, Chennai, India

*Address all correspondence to: ganethkumar@gmail.com and bilisankar@gmail.com

IntechOpen

© 2019 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] UNESCO. Culture and Health, Orientation Texts World Decade for Cultural Development 1988-1997, Document CLT/DEC/PRO-1996. Paris, France: UNESCO Digital Library; 1996. p. 129. <https://unesdoc.unesco.org/ark:/48223/pf0000103546>
- [2] UNESCO. FIT/504-RAF-48 Terminal Report: Promotion of Ethnobotany and the Sustainable Use of Plant Resources in Africa. Paris: UNESCO Digital Library; 1998. p. 60. <https://unesdoc.unesco.org/ark:/48223/pf0000111761>
- [3] Chandan BK, Sharma AK, Anand KK. *Boerhaavia diffusa*: A study of its hepatoprotective activity. *Journal of Ethnopharmacology*. 1991;**31**(3):299-307
- [4] Chopra GL. Angiosperms. *Systematics and Life Cycle*. Jalandhar, Punjab, India: S. Nagin & Co.; 1969. pp. 361-365
- [5] Heywood VH. *Flowering Plants of the World*. London, UK: Oxford University Press; 1978. pp. 69-70
- [6] The CSIR. *Wealth of India: Raw Materials*. Vol. VII B. New Delhi, India: CSIR; 1988. p. 174
- [7] Lami N, Kadota S, Kikuchi T. Constituents of the roots of *Boerhaavia diffusa* Linn. IV. Isolation and structure determination of boeravinones D, E and F. *Chemical and Pharmaceutical Bulletin*. 1992;**39**(7):1863-1865
- [8] Seth RK, Khamala M, Chaudhury M, Singh S, Sarin JPS. Estimation of punarnavocides, a new antifibrinolytic compound from *Boerhaavia diffusa*. *Indian Drugs*. 1986;**23**:583-584
- [9] Rawat AKS, Mehrotra S, Tripathi SK, Shama U. Hepatoprotective activity in punarnava: A popular Indian ethnomedicine. *Journal of Ethnopharmacology*. 1997;**56**(1):61-68
- [10] Verma HN, Awasthi LP. Occurrence of a highly antiviral agent in plants treated with *Boerhaavia diffusa* inhibitor. *Canadian Journal of Botany*. 1980;**2**:41-44
- [11] Verma HN, Awasthi LP. Antiviral activity of *Boerhaavia diffusa* root extract and physical properties of virus inhibitor. *Canadian Journal of Botany*. 1979;**57**:926-932
- [12] Awasthi LP, Kluge S, Verma N. Characteristics of antiviral agents induced by *Boerhaavia diffusa* glycoprotein in host plants. *Indian Journal of Virology*. 1986;**3**:156-169, 1989
- [13] Awasthi LP, Menzel G. Effect of root extract from *Boerhaavia diffusa* containing an antiviral principle upon plaque formation of RNA bacteriophages. *Zentralblatt für Bakteriologie*. 1986;**141**:415-419
- [14] Sawant M, Isaac JC, Narayanan S. Analgesic Studies on Total alkaloids and alcohol extracts of *Eclipta alba* (Linn.) Hassk. *Phytotherapy Research*. 2004;**18**(2):111-113
- [15] Holm Leroy G, Plucknett DL, Pancho JV, Herberger JP. *The world's Worst Weeds: Distribution and Biology*. Honolulu, HI: East-West Center/ University Press of Hawaii; 1977. p. 609
- [16] Smith Albert C. *Flora Vitiensis Nova: A New Flora of Fiji*. Vol. 5. Lawai, Kauai, Hawaii: National Tropical Botanical Garden; 1991. p. 626
- [17] Henty E, Pritchard GH. *Weeds of New Guinea and their Control*. 2nd ed. Department of Forests, Division of Botany, Botany Bull. No. 7. Lae, Papua New Guinea 180, 1975

- [18] Das D, Chakravarty AKA. New terthienyl aldehyde from *Eclipta alba*. Indian Journal of Chemistry. 1991;**30B**(11):1052-1053
- [19] Asolkar LV, Kakkar KK, Chakre OJ. Second Supplement to Glossary of Indian Medicinal Plants with Active Principles—Part I (A.K). New Delhi: Publication and Information Directorate, CSIR; 1992
- [20] Stuart Rev GA. Chinese Materia Medica. Taipei: Southern Materials Centre; 2000
- [21] Lami N, Kadota S, Tezuka Y, Kikuchi T. Constituents of the roots of *Boerhaavia diffusa* Linn. II. Structure and stereochemistry of a new rotenoid boeravinone C2. Chemical and Pharmaceutical Journal. 1990;**38**(6):1558-1562
- [22] Chevallier A. Encyclopedia of Herbal Medicine: Natural Health. 2nd ed. USA: Dorling Kindersley Book; 2000. p. 336
- [23] Bown D. Encyclopaedia of Herbs and Their Uses. London: Dorling Kindersley; 1995
- [24] Murphy RC, Hammarstrom S, Samuelsson B, Leukotriene C. A slow reacting substance from marine mastocytoma cells. Proceedings of the National Academy of Sciences. 1979;**76**(9):4275-4279
- [25] Sunita Dalal SKK, Sastry K, Rana SVS. Phytochemical screening of methanolic extract and antibacterial activity of active principles of hepatoprotective herb, *Eclipta alba*. Ethnobotanical Leaflets. 2010;**14**:248-258
- [26] Razdan R, Imranulla A, Dev MJ. Preventive and curative effects of Vedic guard against antitubercular drugs induced hepatic damage in rats. Pharmacognosy Magazine. 2008;**4**(15):182-188
- [27] Cabieses F. Apuntes de Medicina Traditional (La Racionalizacion de Lo Irracional) [Notes of Traditional Medicine]. Lima-Peru: Consejo Nacional De Ciencia Y Tecnologia; 1993. p. 414
- [28] ASL T. Medicinal Plants of Suriname. Uses and Chemical Constituents. Suriname: Chemical Laboratory, Ministry of Agriculture, Animal Husbandry and Fisheries; 1987. p. 92
- [29] Morton JF. Atlas of Medicinal Plants of Middle America. Library of Congress Cataloging in Publication Data. Springfield, IL: Thomas Books; 1981. p. 1420
- [30] Foo LY. Amarulone, novel cyclic hydrolysable tannin from *Phyllanthus amarus*. Natural Product Letters. 1993;**3**:45-52
- [31] Houghton PJ, Woldemariam TZ, Shea S, Thyagarajan SP. Two securinegatype alkaloids from *Phyllanthus amarus*. Phytochemistry. 1996;**43**:715-717
- [32] Nanden-Amattaram T. Medicinale Planten: Tips en Simpele Recepten voor Een Goede Gezondheid [Medicinal Plants and Simple Recipes for a Good Health]. Paramaribo, Suriname; 1998. p. 18
- [33] De B, Datta PC. Pharmacognostic evaluation of *Phyllanthus amarus*. International Journal of Crude Drug Research. 1990;**28**(2):81-88
- [34] Heyde H. Medicijn Planten in Suriname (Den Dresi Wiwiri Foe Sranan) [Medicinal Plants in Suriname]. Paramaribo: Stichting Gezondheidsplanten Informaite (SGI); 1990. p. 157
- [35] Jayanthi V, Madanagopalan N, Thyagarajan SP, Balakumar V, Parimalam S, Malathi S. Value of herbal medicines, *Phyllanthus niruri*, *Eclipta alba*, *Piper Longus*, Thippili (Tamil) and combination of *Phyllanthus niruri* and *Racinus communis*

(Icterus-Pharm. Products) in acute viral hepatitis. Journal of Gastroenterology and Hepatology. 1988;3:533-534

[36] Thyagarajan SP, Jayaram S, Gopalakrishnan V, Hari R, Jeyakumar P, Sripathi MS. Herbal medicines for liver diseases in India. Journal of Gastroenterology and Hepatology. 1993;17:370-376

[37] Tan W, Jaganath I, Manikam I. Evaluation of antiviral activities of four local Malaysian *Phyllanthus* species against Herpes simplex viruses and possible antiviral target. International Journal of Medical Sciences. 2013;10(13):1817-1892

[38] Mitra R, Gupta RC. Punarnava: An ayurvedic drug of repute. In: Applied Botany Abstracts. Vol. 17, Issue 3. Lucknow, Uttar Pradesh, India: Economic Botany Information Service, National Botanical Research Institute; 1997. pp. 209-227

[39] Puri HS. Rasayana: Ayurvedic Herbs for Longevity and Rejuvenation. London: Taylor & Francis; 2003. pp. 80-85