

BIOCHEMISTRY AND PHYTOCHEMISTRY OF *TRIPHALA*, THREE MEDICINAL FRUITS, MEDICINAL PROPERTIES, BIOACTIVE COMPOUNDS AND THERAPEUTIC POTENTIAL

Pankaj Singh

Department of Biotechnology, Dr. Rammanohar Lohia Avadh University, Ayodhya-224001, India

Pankaj Kumar Tripathi

Institute of Plant Sciences, Agricultural Research Organization (ARO), Volcani Center 68 HaMacabim Road, Rishon Lezion 7505101, Israel

Ram Lakhan Singh*

Department of Biochemistry, Dr. Rammanohar Lohia Avadh University, Ayodhya-224001, India

Present Address: Nilamber-Pitamber University, Medininagar-822101, Jharkhand, India

Keywords: *Triphala*, Ayurvedic, Antioxidant, Gallic acid, Anti-cancerous, Hepatoprotective, Antidiabetic, *Embllica officinalis*, *Terminalia chebula*, *Terminalia bellirica*

Content

1. Introduction
 - 1.1. Constituents of Triphala
 - 1.2. Different Commercial Brands of Triphala
2. Bioactive phytochemicals of *Triphala*
3. Therapeutic application
4. Pharmacological properties of *Triphala*
 - 4.1. Antioxidant Activity
 - 4.2. Hepatoprotective Effect
 - 4.3. Immunomodulatory Effects
 - 4.4. Triphala Supports Gastrointestinal Health
 - 4.5. Anti-inflammatory Effects of Triphala
 - 4.6. Antidiabetic Potential
 - 4.7. Neuroprotective Potential
 - 4.8. Anticancer Properties
 - 4.9. Hypolipidemic Effect
 - 4.10. Oral Health and Antimicrobial Potential
 - 4.11. Radioprotective Effects
 - 4.12. Antineoplastic Activity
 - 4.13. Triphala for Eye Care
 - 4.14. Stress-reducing Potential
 - 4.15. Effects on Aging
 - 4.16. Effects on Intestinal Gut Microflora
5. Safety studies on *Triphala*
6. Conclusions and recommendations

Glossary

Bibliography

Biographical Sketches

Summary

Triphala, is an Indian Ayurvedic formulation derived from dried fruits of three herbs, namely Amla (*Emblica officinalis*), Bahera (*Terminalia bellirica*) and Harar (*Terminalia chebula*) in equal proportions (1:1:1). The extract of mixture and its individual ingredients have high medicinal value as described in Ayurveda and showed many human physiological impact on body metabolism, digestion and nutrient absorption. *Triphala* powder contains good amount of important phytoconstituents having antioxidant properties and it is believed that these phytoconstituents are responsible for various therapeutic uses as well as pharmacological effects. It contains four major phenolics *i.e.* gallic acid, syringic acid, tannic acid and epicatechin along with ascorbic acid. *T. bellirica* contains stannic acid, gallic acid and ascorbic acid, while *T. chebula* contains gallic acid, syringic acid, tannic acid, ascorbic acid and epicatechin. Various research investigations have reported variation in concentrations of phytoconstituents among various brands of *Triphala* powder. It may be due to agro-climatic conditions, environmental conditions of storage, different sources of raw materials, different cultivars, and maturity conditions of fruits. Traditionally, Ayurvedic medicine '*Triphala*' has been used in problems related to digestion, poor food assimilation, colon cleansing and in chronic constipation. It possesses various pharmacological properties such as antioxidant, anti-cancerous, hepatoprotective, cardioprotective, hypocholesterolaemic, anti-aging, antidiabetic, antibacterial, antimutagenic, antiparasitic, antiviral, radio protective and many more. All these pharmacological properties of *Triphala* make it one of the most valuable household names and marketed herbal preparations in the Ayurvedic system.

1. Introduction

1.1. Constituents of *Triphala*

Plant kingdom has proved that it is an important source of pharmaceuticals which may be used in the treatment of many diseases (Vemuri et al., 2019). *Triphala* (Sanskrit; *tri* = three and *phala* = fruits) is an Indian Ayurvedic triherbal formulation, in an equi-proportional fruit mixture of three plant species *i.e.* Haritaki (*Terminalia chebula*), Bibhitaki (*Terminalia bellirica*) and Amalaki (*Emblica officinalis*) (Peterson et al., 2017; Tarasiuk et al., 2018; Figure 1). *Churna* means powder. It is also known as the 'three myrobalans'. Although, *Triphala* formulation is generally prepared with equal proportions of fruits from *T. chebula*, *T. bellirica*, and *E. officinalis* but a modified formulation of *Triphala* is also therapeutically used in the ratio 1:2:4 (Nariya et al., 2009). *Triphala* is an ayurvedic medicinal herbal formulation and has active phytochemical components which are responsible for its various pharmacological activities (Kumar et al., 2017). In ancient literature, Charaka Samhita explored that daily intake of *Triphala* Rasayana (*Triphala* alongwith honey and ghee) has the potential to make a person live for more than one hundred years and devoid of diseases (Agnivesa et al., 1976).

The use of natural formulations as medicine is gaining popularity due to its fewer adverse effects (Singh et al., 2014). Natural herbal formulations have been found to be safer medicines as compared to chemical drugs. According to Bulletin of World Health Organization (WHO), around 80% of the world's population relies on medicinal plants as their primary healthcare source (Sandhya et al., 2006). It has been assumed that about 50% of current medicines are developed from natural products and their derivatives, or their analogs (Newman and Cragg, 2007; Pan et al., 2013). Among them, cardiotonics (digoxin), anticancer drugs (paclitaxel and vinca alkaloids) analgesics (morphine), and the antimalarials (quinine and artemisinin) are modern medicines which have been isolated from plant systems (Poojary et al., 2015). *Triphala* is a familiar ayurvedic formulation in India, commonly prescribed by most ayurvedic healthcare practitioners. It exhibits anti-viral, anti-bacterial, anti-fungal and anti-allergic properties (Parveen et al., 2018). Physician Sushrut indicated that *Triphala* is useful in treating ulcers and wounds (Bhishagratna, 1963; Peterson et al., 2017).

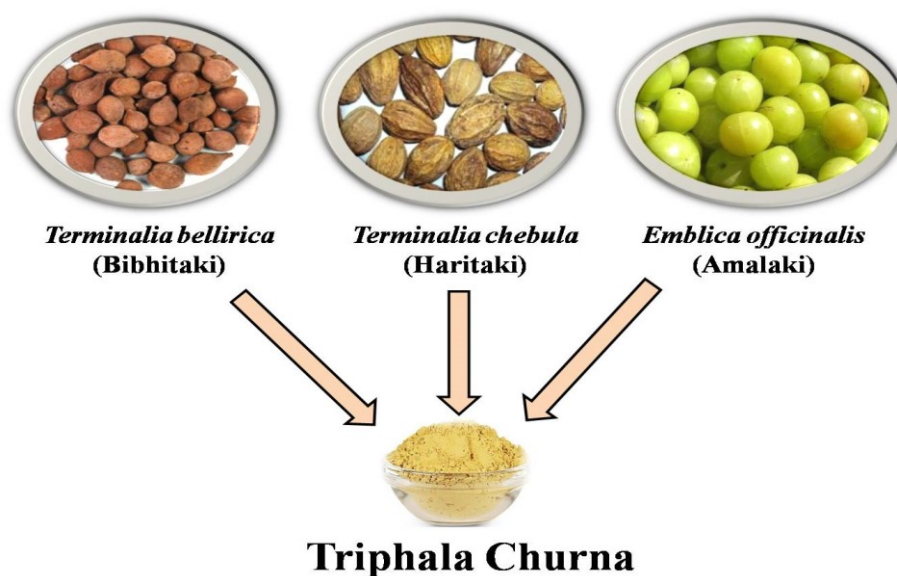


Figure 1. Constituents of *Triphala* Churna

1.1.1. *Emblica Officinalis* (Amalaki)

Emblica officinalis (EO), known as Indian Gooseberry or Amla in Hindi, has been used in Indian traditional system of medicine for thousands of years. *Emblica officinalis* was described by Joseph Gaertner in ‘*De Fructibus et Seminibus Plantarum*’ in 1791 (Tropicos). Now it is known as *Phyllanthus emblica* L. (Figure 2). It is native to India, East Himalaya, West Himalaya, Bangladesh, Malaya, Cambodia, China South-Central, Pakistan, Thailand, China Southeast, Myanmar, Sri Lanka, Sumatera, Taiwan, and Vietnam. The fruit of this plant is of great medicinal value. It has a high content of Vitamin C. Extracts from various parts of *E. officinalis*, especially fruit, contain numerous phytoconstituents *i.e.* polyphenols like gallic acid, ellagic acid, quercetin, two major alkaloids (phyllantidine and phyllantine), astragalin-flavanol, emblicol, phyllembic acid, emblicanin-B, emblicanin, different tannins, punigluconin-tanin, pedunculagin, terchebin, trigalloylglucose, corilagin, protein, carbohydrates, linoleic

acid, minerals, vitamins, amino acids etc (Variya et al., 2016; Narendra and Khurana, 2018).

It is used in fever, vomiting, indigestion, diarrhea, dysentery and haemorrhage. It has powerful antioxidant properties due to its high vitamin C content. It removes or neutralizes the excess free radicals generated due to oxidative stress and thereby reduces progression of degenerative diseases and ageing. Regular intake of *E. officinalis* also decreases serum glutamic-oxalacetic transaminase (SGOT), serum glutamic-pyruvic transaminase (SGPT) and lactate dehydrogenase (LDH) levels in blood which indicate its cardio protective properties. *E. officinalis* has other wide number of pharmacological properties such as antidiabetic, antimicrobial, antimutagenic, anti-inflammatory, hepatoprotective, hypolipidemic, antitumor, gastro protective and chemo-protective.

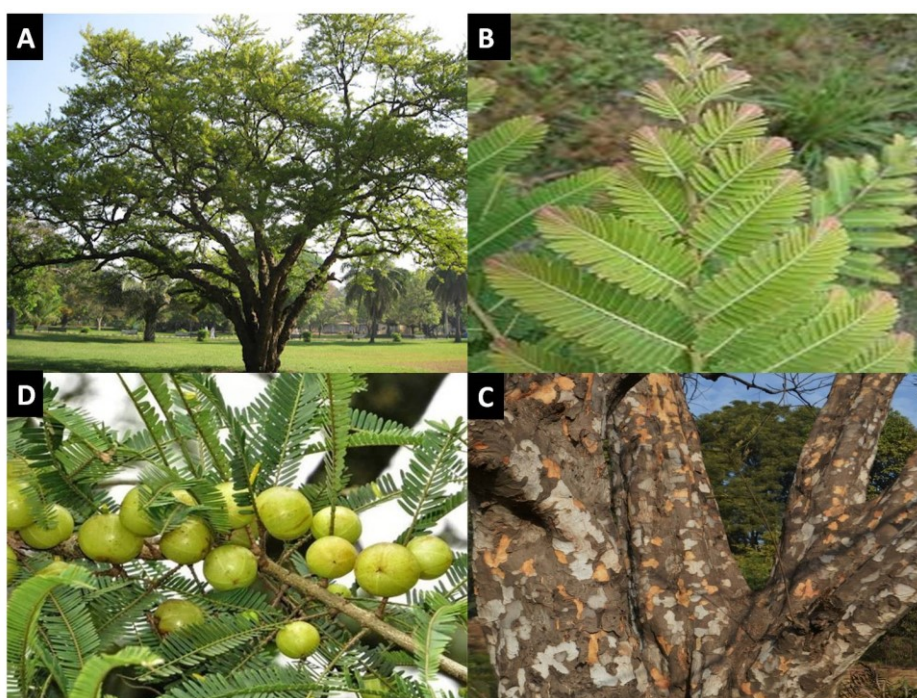


Figure 2. *Emblica officinalis* A. Plant B. Leaf C. Stem D. Fruit

1.1.2. *Terminalia Bellirica* (Bibhitaki)

Terminalia bellirica (TB) is known as Bibhitaki' in Sanskrit and "Bahera" in Hindi, is a large tree, up to 40 m high. *Terminalia bellirica* was first described as '*Myrobalanus bellirica*' by Joseph Gaertner in '*De Fructibus et Seminibus Plantarum*' in 1791 and later described taxonomically in its current nomenclature by William Roxburgh in '*Plants of the Coast of Coromandel*' in 1805 as *Terminalia bellirica* Roxb (Figure 3). Leaves are clustered towards the end of branches, and it is petiolate and broadly elliptic type. Flowers are solitary, simple, axillary and greenish-yellow in color. It is native to Bangladesh, Borneo, Cambodia, China South-Central, East Himalaya, India, Jawa, Lesser Sunda Island, Maluku, Myanmar, Nepal, Pakistan, Sri Lanka, Sulawesi, Sumatera, Thailand and Vietnam. In India, the distribution of *T. bellirica* is found in deciduous forests throughout the greater part of India, in the upper Gangetic plains,

Nagpur, Bihar, Orissa, West Bengal, Konkan, Deccan and most of South India (Hazra, 2019).

Fruits mainly contain chebulagic acid, gallic acid, ellagic acid, hexahydroxydiphenic acid, galloyl glucose, β - sitosterol, ethyl gallate, methyl ester, mannitol, glucose, galactose, and rhamnose. The ripe dry fruit of *T. bellirica*, which is known as Belleric Myrobalan, is astringent, bitter, tonic and laxative. It is given in piles, dropsy, diarrhea, leprosy, biliousness, dyspepsia and headache. *T. bellirica* fruit extract shows antidiabetic, hepato-protective, antimutagenic, hypolipidemic, antimicrobial, antiviral, antimalarial, anti-HIV, antifungal, anti-mutagenic activities and lowers down the risk associated with atherosclerosis. Different parts of *Terminalia bellirica* are used in the treatment of wound healing, reducing fever, cough, diarrhea, skin diseases, oral thrush, laxation and in purification and circulation of blood in the body. Ethanolic leaf extract of *T. bellirica* exhibited strong antioxidant activity *in vitro* by chelation to metal ions as well as scavenging free radicals (Singh et al., 2012).

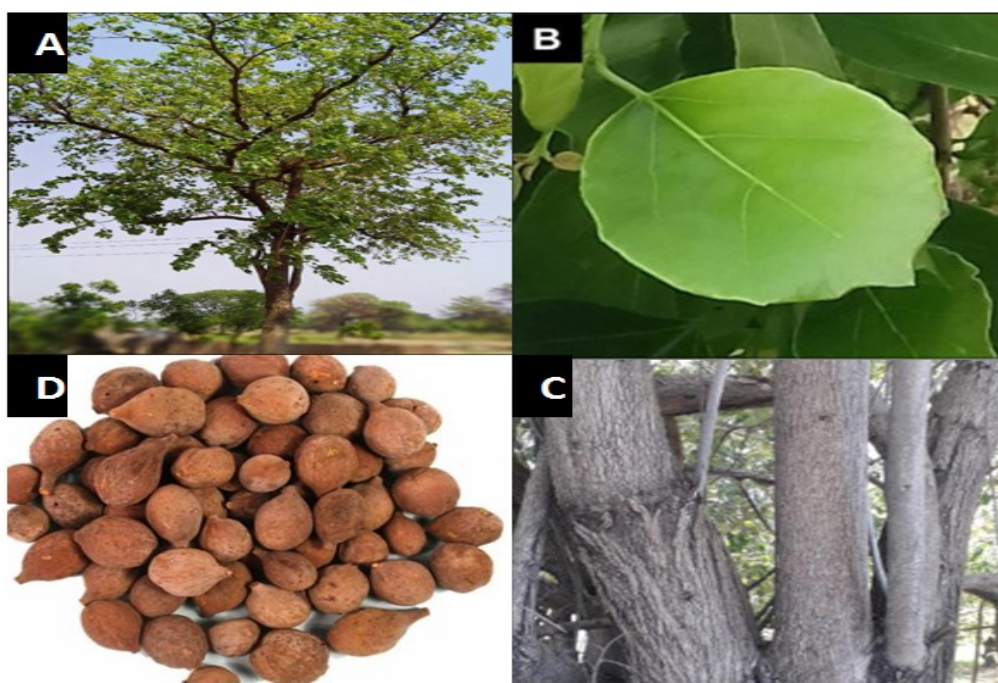


Figure 3. *Terminalia bellirica* A. Plant B. Leaf C. Stem D. Fruit

1.1.3. *Terminalia chebula* (Haritaki)

Terminalia chebula (TC) is the main ingredient in the Ayurvedic formulation *Triphala*, which is used to treat various dysfunctions. *T. chebula* has been extensively used in Ayurveda, Unani and Homoeopathic medicines and is known as “king” of Mongolian and Tibetan medicines (Zhang et al., 2018). *Terminalia chebula* was described by Anders Jahan Retzius in ‘*Observationes Botanicae*’ in 1789 (Figure 4). It is native to Bangladesh, Cambodia, China South-Central, East Himalaya, India, Laos, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand and Vietnam. *T. chebula* tree commonly found in Northern India and also in South India at 1,000-3000 feet and up to 6000 feet in Travancore; higher forests of the Mumbai Ghats, Satpuras, Belgaum and Kanara (Mokat

et al., 2011). *T. chebula* is a deciduous tree growing up to 30 m height with a trunk diameter up to 1 m. Leaves alternate or opposite, thin-coriaceous, ovate or elliptic-obovate, with 2 glands at the base of leaf blade. Flowers white to yellow, monoecious, have a strong, unpleasant odour. Fruits are smooth, drupe-like, and yellow to orange in colour.

The most important product of this tree is the dried fruit which constitutes the black myrobalan of commerce, one of the most valuable Indian tanning materials. *T. chebula* exhibits a number of pharmacological properties due to the presence of a large number of phytoconstituents having antioxidant properties. A number of glycosides are present in *T. chebula*, including chebulosides I and II, arjungenin, arjunglucoside I and triterpenes. Plant extract contains alkaloids, flavonoids, phenols, carbohydrates, glycosides, terpenoids, saponins, proteins, and tannins (Pourmorad et al., 2006; Vemuri et al., 2019). Apart from this, other components include a coumarin connected with gallic acids called chebulin, chebulinic acid, ellagic acid, gallic acid, ethyl gallate, punicalagin, terflavin A, terchebin, 2,4-chebulyl- β -D-glucopyranose, luteolin and tannic acid. In addition, *T. chebula* also contains terflavin B, a type of tannin.

The fruit of *T. chebula* is an efficacious laxative, stomachic and tonic. The fruit pulp is given in chronic diarrhoea, dysentery, asthma, urinary disorders, vomiting, enlarged spleen and liver. It is used externally in wound healing and application to chronic ulcer. Modern pharmacological studies showed that it has many biological activities, including antimicrobial, anti-inflammatory, anti-oxidation as well as antitumor properties (Zhang et al., 2016).

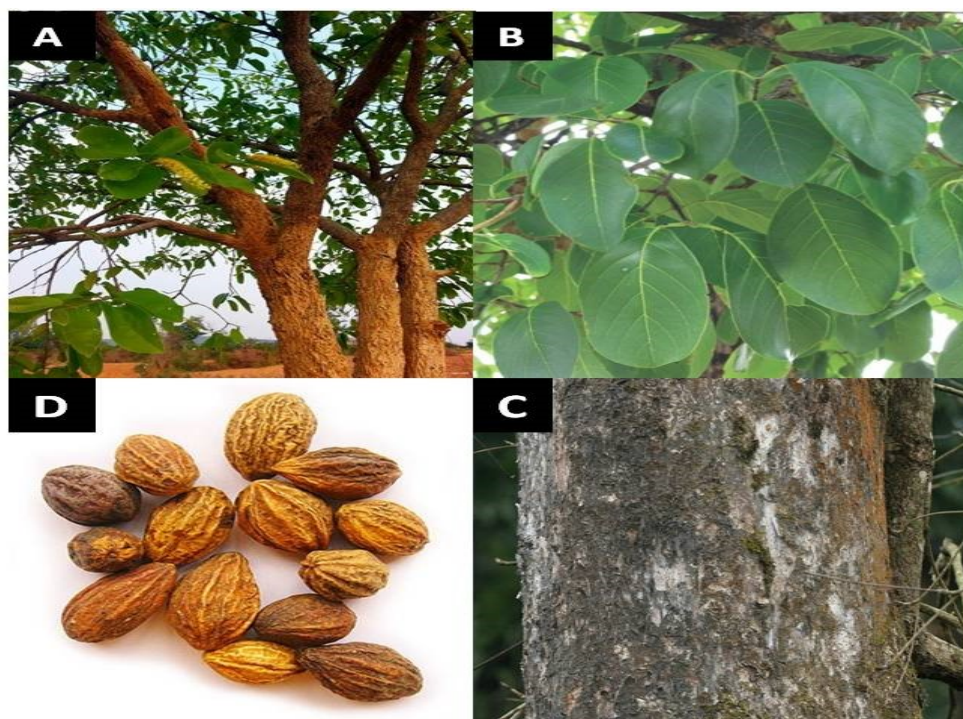


Figure 4. *Terminalia chebula* A. Plant B. Leaf C. Stem D. Fruit

1.2. Different Commercial Brands of *Triphala*

Triphala Churna can be purchased at health food stores, medical stores or online. A number of brands of *Triphala* are available in the market. It is available in many forms, including capsule, powder or liquid under different brand names such as Patanjali *Triphala* Churna, Baidyanath *Triphala* Juice, Dabur *Triphala* Churna, Arogyapath *Triphala* Powder, Healthvit *Triphala* Powder, Kapiva *Triphala* Juice, Banyan Botanicals *Triphala*, Toniiq *Triphala*, Organic India *Triphala*, Veda Organic *Triphala*, BRI Nutrition *Triphala*, Jiva Botanicals *Triphala*, Gaia Herbs *Triphala*, Maharishi Ayurveda Organic *Triphala*, Planetary Herbals *Triphala*, Himalaya Organic *Triphala*, Terrasoul Superfoods Organic *Triphala*, Nature Bell *Triphala* etc. The variability in efficacy in different brands of *Triphala* depends on several factors such as source of herbs collection, methods of processing, bioavailability, digestion, and absorption of herbal components due to inherent differences in gut microbiota that catalyze the biotransformation of the various *Triphala* components. It is suggested to take *Triphala* between meals on an empty stomach for maximum absorption and recommended doses range from 500 mg to one gram per day. *Triphala* Churna can be taken alone or in various combinations like mixed with warm water and honey, mixed with ghee, with honey and ghee, decoction, black ash, sugar etc. in the treatment of various disorders (Figure 5).

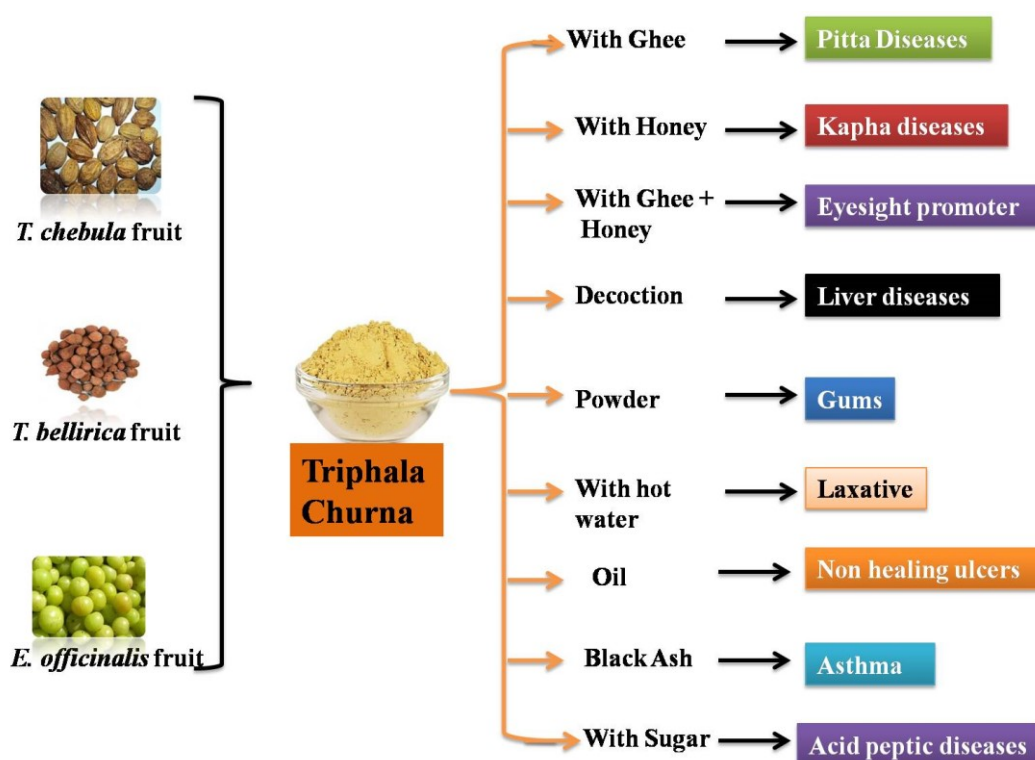


Figure 5. Combinations of *Triphala* Churna used in the treatment of various diseases

Significant improvements in the processing of crude plant materials have raised popularity of herbal remedies such as *Triphala*, which maximize the absorption of constituents; otherwise these components are poorly absorbed in the intestine. Despite

these improvements, these preparations still show pronounced variability in efficacy. This efficacy fluctuation is not recognized to spices and it may be due to phytochemicals ingested by people (e.g., plants-derived polyphenolic compounds). These characteristics must be present for true effectiveness of herbal remedies. It relates to the upkeep of human wellbeing and/or capability to reverse chronic disease states. For example, *Triphala*-derived polyphenols like chebulinic acid are transformed by the human gut microbiota into metabolites such as urolithins, which have the potential to prevent oxidative damage (Olennikov et al., 2015). The bioactivity of *Triphala* is induced by the gut microbiome to supply a widened spectrum and abundance of anti-inflammatory compounds. Reports also showed that co-administration of specific probiotic species with *Triphala*, enhanced absorption of phytochemicals in both the elderly and persons of all ages (Peterson et al., 2017). Thus, probiotic formulations comprising of bacterial species will be effective methods for improved digestion, bioabsorption and bioactivity of *Triphala*.

2. Bioactive Phytochemicals of *Triphala*

Chemical analysis of *Triphala* Churna revealed that it has high content of gallic acid, vitamin C, ellagic acid, chebulic acid, quercetin, luteolin, chebulinic acid, bellaricanin, β -sitosterol and flavonoids (Kumar et al., 2017) (Figure 6). Phenolic acids, flavonoids and tannins are the most commonly found polyphenolic compounds in plant extracts of *Triphala* (Naik et al., 2005; Sharma et al., 2014). Some of the important chemical compounds reported from this formulation are phenolics (25-38%), constitutes mostly of tannin (35%), gallic acid (3-7%), ellagic acid (2%), chebulagic and chebulinic acid (5%), epicatechin, syringic acid along with good amount of ascorbic acid (0.050-0.33%) flavonoids and saponin (Mukherjee et al., 2006; Naik et al., 2006; Sharma et al., 2012; Pharmacy et al., 2016). It also contains carbohydrates, steroids, tannins, terpenoids, alkaloids, flavonoids, cardiac glycosides, saponins, coumarins etc. *Triphala* also contains several other bioactive compounds such as flavonoids (luteolin and quercetin), anthraquinones, saponins, amino acids, fatty acids and various carbohydrates. Polyphenol chebulinic acid is also transformed by the gut microbiota into other bioactive metabolites, which have the potential to prevent oxidative damage (Olennikov et al., 2015). Major constituents are potent antioxidants that may account, at the minimum in part, for the observed immune-modulatory activity of the formula (Lee et al., 2005; Lu et al., 2012; Belapurkar et al., 2014).

-
-

TO ACCESS ALL THE 38 PAGES OF THIS CHAPTER,
Visit: <http://www.eolss.net/Eolss-sampleAllChapter.aspx>

Bibliography

- Abraham S., Kumar M.S., Sehgal P.K., Nitish S., Jayakumar N.D. (2005). Evaluation of the inhibitory effect of *Triphala* on PMN-type matrix metalloproteinase (MMP-9). *J. Periodontol.* 76, 497–502. [This paper discusses the oral health and anti-cancerous properties of *Triphala*]
- Agnivesa C., Sarm R.M., Dash B. (1976). *Agniveas's Caraka samhita: Text with English Translation & Critical Exposition Based on Cakrapalli Datta's Ayurveda Dipika*, 1st ed. Varanasi, India: Chowkhamba Sanskrit Series Office. [This paper discusses the various aspects of *Triphala*]
- Ahmed S., Ding X., Sharma A. (2021). Exploring scientific validation of *Triphala* Rasayana in ayurveda as a source of rejuvenation for contemporary healthcare: An update. *J. Ethnopharmacol.* 273:113829. [This paper discusses the pharmacological aspects of *Triphala*]
- Awasthy V.M, Shajahan M. A., Indulekha V.C. (2019). Hepatoprotective effect of *Triphala* and its combinations - in hepg2 cell lines. *Int. J. of Adv. Res.* 7, 346-352. [This paper discusses the hepatoprotective properties of *Triphala*]
- Bajaj N., Tandon S. (2011). The effect of *Triphala* and Chlorhexidine mouthwash on dental plaque, gingival inflammation, and microbial growth. *Int. J. Ayurveda. Res.* 2(1), 29–36. [This paper discusses the oral protective properties of *Triphala*]
- Baliga M.S. (2010). *Triphala*, Ayurvedic formulation for treating and preventing cancer: A review. *J. Altern. Complement. Med.* 16(12), 1301–1308. [This paper discusses the anti-cancerous properties of *Triphala*]
- Baliga M.S., Meera S., Mathai B., Rai M.P., Pawar. V., Palatty P.L. (2012). Scientific validation of the ethnomedicinal properties of the Ayurvedic drug *Triphala*: a review. *Chin. J. Integr. Med.* 18(12), 946-954. [This paper discusses the pharmacological aspects of *Triphala*]
- Banjare J., Raina P., Mansara P., Ghanekar R.K., Bhalerao S. (2018). *Triphala*, Regulates Adipogenesis through Modulation of Expression of Adipogenic Genes in 3T3-L1 Cell Line. *Pharmacogn. Mag.* 13(4):S834-S839. [This paper discusses the anti-obesity aspects of *Triphala*]
- Baskaran U.L., Martin S.J., Mahaboobkhan R., Prince S.E. (2015). Protective role of *Triphala*, an Indian traditional herbal formulation, against the nephrotoxic effects of bromobenzene in Wistar albino rats. *J. Integr. Med.* 13, 115–121. [This paper discusses the Anti-inflammatory effects of *Triphala*]
- Belapurkar P., Goyal P., Tiwari-Barua P. (2014). Immunomodulatory effects of *Triphala* and its individual constituents: a review. *Indian J. Pharma. Sci.* 76(6), 467-475. [This paper discusses the Immunomodulatory effects of *Triphala*]
- Bhatnagar S., Rani A., Kumari R. (2015). Therapeutic Potential of *Triphala* against Human Diseases. *Int. J. Pharm. Sci. Rev. Res.* 31(2), 5-13. [This paper discusses the therapeutic potential of *Triphala*]
- Bhishagratna K. (1963). *An English Translation of the Sushruta Samhita, Based on Original Sanskrit Text, with a Full and Comprehensive Introd., Additional Texts, Different Readings, Notes, Comparative Views, Index, Glossary And Plates*, 2nd ed. Varanasi, India: Chowkhamba Sanskrit Series Office. [This chapter discusses the various aspects about *Triphala*]
- Biradar Y.S., Singh R., Sharma K., Dhalwal K., Bodhankar S.L., Khandelwal K.R. (2008a). Evaluation of anti-diarrhoeal property and acute toxicity of *Triphala* Mashi, an Ayurvedic formulation. *J. Herb. Pharmacother.* 7(3-4), 203-212. [This paper discusses the gastroprotective properties of *Triphala*]
- Biradar Y.S., Jagatap S., Khandelwal K.R., Singhanian S.S. (2008b). Exploring of antimicrobial activity of *Triphala* Mashi—An ayurvedic formulation. *Evid. Based. Complement. Altern. Med.* 5, 107–113. [This paper discusses the antimicrobial properties of *Triphala*]
- Boto-Ordóñez M., Urpi-Sarda M., Queipo-Ortuno M.I., Tulipani S., Tinahones F.J., Andres-Lacueva C. (2014). High levels of Bifidobacteria are associated with increased levels of anthocyanin microbial metabolites: A randomized clinical trial. *Food. Funct.* 5(8), 1932–1938. [This paper discusses the antimicrobial properties of *Triphala*]

- Chainani S.H., Siddana S., Reddy C., Manjunathappa T.H., Manjunath M., Rudraswamy S. (2014). Antiplatelet and antigingivitis efficacy of *Triphala* and chlorhexidine mouthrinse among schoolchildren—A cross-over, double-blind, randomised controlled trial. *Oral. Health. Prev. Dent.* 12 (3), 209–217. [This paper discusses the oral protective and antimicrobial properties of *Triphala*]
- Chung H.H., Kim H.J., Jang K.S., Kim M., Yang J., Kang K.S., Kim H.L., Yoon B.I., Lee M.O., Lee B.H., Kim J.H., Lee Y.S., Kong G. (2006). Analysis of differential gene expression profiles on D-galactosamine-induced acute mouse liver injury and regeneration. *Toxicology*. 227(1-2), 136–144. [This paper discusses the hepatoprotective properties of *Triphala*]
- Deep G., Monisha D., Rao, A.R., Kale, R. (2005). Chemopreventive potential of *Triphala* (a composite Indian drug) on Benzo (a) pyrene induced forestomach tumorigenesis in murine tumor modelsystem. *J. Exp. Clin. Cancer Res.* 24, 555-63. [This paper discusses the anti-cancerous properties of *Triphala*]
- Deshpande A., Tandon S., Deshpande N. (2014). Low resource screening method of pre-cancerous lesions and its reversal by *Triphala* in teen-age Indian population. *Ayu.* 35(2), 160–167. [This paper discusses the anti-cancerous properties of *Triphala*]
- Dhanalakshmi S., Devi R.S., Srikumar R., Manikandan S., Thangaraj R. (2007). Protective effect of *Triphala* on cold stress-induced behavioral and biochemical abnormalities in rats. *Yakugaku Zasshi.* 127(11), 1863–1867. [This paper discusses the stress reducing and neuroprotective properties of *Triphala*]
- Eid, F., Helal, E., El-Wahsh, A. (2011). Hypolipidemic effect of *Triphala* (*Terminalia chebula*, *Terminalia bellerica* and *Emblia officinalis*) on female albino rats. *Egypt. J. Hosp. Med.* 43(1), 226-240. [This paper discusses the Hypolipidemic effect of *Triphala*]
- Elmore S. (2007). Apoptosis: a review of programmed cell death. *Toxicol. Pathol.* 35(4), 495–516. [This paper discusses the anti-cancerous properties of *Triphala*]
- Gajarmal A.A., Rath S.K. (2016). Immunomodulatory Activity of *Triphala* and its Individual Constituents w.s.r. to Rasayana - A Review. *Int. J. Ayu. Pharm. Chem.* 5(1), 231-244. [This paper discusses the immunomodulatory properties of *Triphala*]
- Ganeshpurkar A., Jain S., Agarwal S. (2015). Experimental studies on glycolytic enzyme inhibitory and antiglycation potential of *Triphala*. *Ayu.* 36, 96–100. [This paper discusses the antidiabetic properties of *Triphala*]
- Gautam A.K., Avasthi S., Sharma A., Bhadauria R. (2012). Antifungal potential of *Triphala* Churna ingredients against *Aspergillus* species associated with them during storage. *Pak. J. Biol. Sci.* 15, 244–249. [This paper discusses the antimicrobial properties of *Triphala*]
- Girdhani S., Bhosle S.M., Thulsidas S.A., Kumar A., Mishra K.P. (2005). Potential of radiosensitizing agents in cancer chemo-radiotherapy. *J. Cancer Res. Ther.* 1, 129–131. [This paper discusses the radioprotective properties of *Triphala*]
- Gopinathan G., Dhiman K.S. (2013). *Triphala* in Eye Diseases: A Critical Review. *J. Homeop. Ayurv. Med.* 2:123. [This paper discusses the eye protective properties of *Triphala*]
- Gupta R., Singh R.L., Singh P. (2015a). Quantification of Phytochemicals and Evaluation of Antioxidant Potential of Ethanolic Leaf Extract of *Terminalia bellerica*, *Terminalia chebula* and *Emblia officinalis* vis-a-vis *Triphala*. *Int. J. Pharm. Sci. Rev. Res.* 32(2), 14-22. [This paper discusses the antioxidant properties of *Triphala*]
- Gupta R., Gupta A, Singh R.L. (2015b). Hepatoprotective Activities of *Triphala* and Its Constituents. *Int. J. Pharma. Res. Review.* 4(1), 34-55. [This paper discusses the hepatoprotective activities of *Triphala*]
- Gupta S.K., Kalaiselvan V., Srivastava S., Agrawal S.S., Saxena R. (2010). Evaluation of anticataract potential of *Triphala* in selenite-induced cataract: In vitro and in vivo studies. *J. Ayurveda. Integr. Med.* 1, 280–286. [This paper discusses the eye protective properties of *Triphala*]
- Gurjar S., Pal A., Kapur S. (2012). *Triphala* and its constituents ameliorate visceral adiposity from a high-fat diet in mice with diet-induced obesity. *Altern. Ther. Health. Med.* 18, 38–45. [This paper discusses the antiobesity and hypolipidemic properties of *Triphala*]

- Hamid K.S., Reza K.A., Ranjbar S.H., Esfehiani M.M., Mohammad K., Larijani B. (2013). A systematic review of the antioxidant, anti-diabetic, and anti-obesity effects and safety of *Triphala* herbal formulation. *J. Med. Plants Res.* 7(14), 831-844. [This paper discusses the antioxidant, anti-diabetic, and anti-obesity effects of *Triphala*]
- Hazra K. (2019). Phytochemical investigation of *Terminalia bellirica* fruit inside. *Asian. J. Pharm. Clin. Res.* 12(8): 191-194. [This paper discusses about plant *Terminalia bellirica*]
- Ho M.C., Peng, Y.J., Chen S.J. et al. (2010). Senile cataracts and oxidative stress. *J. Clin. Gerontol. Geriatr.* 1(1), 17-21. [This paper discusses the eye protective properties of *Triphala*]
- Jagadish L., Kumar V.K.A., Kaviyarasan V. (2009). Effect of *Triphala* on dental bio-film. *Indian J. Sci. Technol.* 2, 30-33. [This paper discusses the oral protective and antimicrobial properties of *Triphala*]
- Jagetia G.C., Baliga M.S., Malagi K.J., Sethukumar K.M. (2002). The evaluation of the radioprotective effect of *Triphala* (an ayurvedic rejuvenating drug) in the mice exposed to gamma-radiation. *Phytomedicine.* 9, 99-108. [This paper discusses the radioprotective properties of *Triphala*]
- Jagetia G.C., Malagi K.J., Baliga M.S., Venkatesh P., Veruva R. (2004). *Triphala*, an ayurvedic rasayana drug, protects mice against radiation induced lethality by free-radical scavenging. *J. Altern. Complement Med.* 10, 971-978. [This paper discusses the radioprotective properties of *Triphala*]
- Jimenez N., Curiel J.A., Reveron I., Rivas B.d.l., Muñoz R. (2013). Uncovering the *Lactobacillus plantarum* WCFS1 gallate decarboxylase involved in tannin degradation. *Appl. Environ. Microbiol.* 79(14), 4253-4263. [This paper discusses the intestinal gut microflora supporting properties of *Triphala*]
- Jirankalgikar Y.M., Ashok B.K., Dvivedi R.R. (2012). A comparative evaluation of intestinal transit time of two dosage forms of Haritaki [*Terminalia chebula* Retz.]. *Ayu.* 33(3), 447-449. [This paper discusses the hypolipidemic effect of *Triphala*]
- Kalaiselvan S., Rasool M. (2015a). *Triphala* exhibits anti-arthritis effect by ameliorating bone and cartilage degradation in adjuvant-induced arthritic rats. *Immunol. Invest.* 44, 411-426. [This paper discusses the anti-inflammatory effect of *Triphala*]
- Kalaiselvan S., Rasool M.K. (2015b). The anti-inflammatory effect of *Triphala* in arthritic-induced rats. *Pharm. Biol.* 53, 51-60. [This paper discusses the anti-inflammatory effect of *Triphala*]
- Kalaiselvan S., Rasool M.K. (2016). *Triphala* herbal extract suppresses inflammatory responses in LPS-stimulated RAW 264.7 macrophages and adjuvant-induced arthritic rats via inhibition of NF-kappaB pathway. *J. Immunotoxicol.* 13, 509-525. [This paper discusses the anti-inflammatory effect of *Triphala*]
- Kamali S.H., Khalaj A.R., Hasani-Ranjbar. S., Esfehiani. M.M., Kamalinejad. M., Soheil O., Kamali S.A. (2012). Efficacy of 'Itrifal Saghir', a combination of three medicinal plants in the treatment of obesity; A randomized controlled trial. *Daru.* 20(1), 33. [This paper discusses the anti-obesity and hypolipidemic effect of *Triphala*]
- Kaur S., Michael H., Arora S., Harkonen P.L., Kumar S. (2005). The in vitro cytotoxic and apoptotic activity of *Triphala*-An Indian herbal drug. *J. Ethnopharmacol.* 97(1), 15-20. [This paper discusses the anti-cancerous and antineoplastic properties of *Triphala*]
- Kim H.J., Kim J., Kang K.S., Lee K.T., Yang H.O. (2014). Neuroprotective Effect of Chebulagic Acid via Autophagy Induction in SH-SY5Y Cells. *Biomol. Ther. (Seoul).* 22(4), 275-281. [This paper discusses the Neuroprotective properties of *Triphala*]
- Kumar N.S., Nair A.S., Murali M., Devi P.S.S. (2017). Qualitative phytochemical analysis of *Triphala* extracts. *J. Pharmacogn. Phytochem.* 6(3), 248-251. [This paper discusses about *Triphala*]
- Lee H.S., Won N.H., Kim K.H., Lee H., Jun W., Lee K.W. (2005). Antioxidant effects of aqueous extract of *Terminalia chebula* in vivo and in vitro. *Biol. Pharm. Bull.* 28(9), 1639-1644. [This paper discusses the Antioxidant effects of extract of *Terminalia chebula*, a constituents of *Triphala*]
- Lu K., Chakroborty D., Sarkar C., Lu T., Xie Z., Liu Z., Basu S. (2012). *Triphala* and Its Active Constituent Chebulinic Acid Are Natural Inhibitors of Vascular Endothelial Growth Factor-A Mediated Angiogenesis. *PloS One.* 7. e43934. 10.1371/journal.pone.0043934. [This paper discusses the anti-cancerous and antineoplastic properties of *Triphala*]

- Lu Z., Nie G., Belton P.S., Tang H., Zhao B. (2006). Structure-activity relationship analysis of antioxidant ability and neuroprotective effect of gallic acid derivatives. *Neurochem. Int.* 48(4), 263-274. [This paper discusses the antioxidant ability and neuroprotective effect of *Triphala*]
- Mahaboob K.R., Evan P.S., Kumar L., Nithya P. (2007). Therapeutic effect of Indian ayurvedic herbal formulation *Triphala* on acetaminophen induced hepatotoxicity in mice. *J. Pharmacol. Toxicology.* 2:725-731. [This paper discusses the hepatoprotective properties of *Triphala*]
- Mamgain P., Kandwal A., Mamgain R.K. (2017). Comparative evaluation of *Triphala* and ela decoction with 0.2% chlorhexidine as mouthwash in the treatment of plaque-induced gingivitis and halitosis: A randomized controlled clinical trial. *J. Evid. Based. Complement. Altern. Med.* 22(3), 468-472. [This paper discusses the oral protective properties of *Triphala*]
- Maruthappan V., Shree K.S. (2010). Hypolipidemic activity of haritaki (*Terminalia chebula*) in atherogenic diet induced hyperlipidemic rats. *J. Adv. Pharm. Technol. Res.* 1, 229–235. [This paper discusses the hypolipidemic activity of *Terminalia chebula* a constituents of *Triphala*]
- Maurya D., DevaSagayam T.P.A., Nair C.K.K. (2006). Some novel approaches for radioprotective and the beneficial effect of natural product. *Ind. J. Exp. Biol.* 44, 93-114. [This paper discusses the radioprotective properties of *Triphala*]
- Mokat D.N., Navhale V.C., Thorat A.P., Mane A.V., Bhawe S.G. (2011). Variability studies in *Terminalia chebula* Retz. (*Chebolic Myrobalan*). *Int. J. for Usuf. Mngt.* 12:19-33. [This paper discusses about *Terminalia chebula*]
- Mukherjee P.K., Rai S., Bhattacharyya S., Debnath P.K., Biswas T.K., Jana U., Pandit S., Saha B.P., Paul P.K. (2006). Clinical Study of '*Triphala*' – A Well Known Phytomedicine from India. *Iran. J. Pharmacol. Ther.* 5(1), 51-54. [This paper discusses the constituents of *Triphala*]
- Naik G.H., Priyadarsini K.I., Bhagirathi R.G., Mishra B., Mishra K.P., Banavalikar M.M., Mohan H. (2005). *In vitro* antioxidant studies and free radical reactions of *Triphala*, an ayurvedic formulation and its constituents. *Phytother. Res.* 19, 582–586. [This paper discusses the antioxidant properties of *Triphala*]
- Naik G.H., Priyadarsini K.I., Mohan H. (2006). Free radical scavenging reactions and phytochemical analysis of *Triphala*, an ayurvedic formulation. *Curr. Sci.* 90, 1100-1105. [This paper discusses the antioxidant properties of *Triphala*]
- Narendra K., Khurana S.M. (2018). Phytochemicals and medicinal potential of the *Terminalia bellirica* Roxb. (*Bahera*). *Ind. J. Nat. Prod. Rad.* 9:97-107. . [This paper discusses the constituents of *Triphala*]
- Nariya M., Shukla V., Jain S., Ravishankar B. (2009). Comparison of enteroprotective efficacy of *Triphala* formulations (Indian Herbal Drug) on methotrexate-induced small intestinal damage in rats. *Phytother. Res.* 23, 1092–1098. [This paper discusses the gastroprotective properties of *Triphala*]
- Nariya M.B., Shukla V.J., Ravishankar B., Jain S.M. (2011). Comparison of gastroprotective effects of *Triphala* formulations on stress-induced ulcer in rats. *Indian J. Pharm. Sci.* 73, 682–687. [This paper discusses the gastroprotective properties of *Triphala*]
- Newman D.J., Cragg G.M. (2007). Natural Products as Sources of New Drugs over the Last 25 Years. *J. Nat. Prod.* 70 (3), 461-477. [This paper discusses about *Triphala*]
- Ning W., Li S., Tsering J., Ma Y., Li H., Ma Y., Ogbuehi A.C., Pan H., Li H., Hu S., Liu X., Deng Y., Zhang J., Hu X. (2021). Protective Effect of *Triphala* against Oxidative Stress Induced Neurotoxicity. *Bio.Med. Res. Int.* 2021, Article ID 6674988. [This paper discusses the neuroprotective properties of *Triphala*]
- Norbury C.J., Hickson I.D. (2001). Cellular responses to DNA damage. *Annu. Rev. Pharmacol. Toxicol.* 41, 367–401. [This paper discusses the gastroprotective properties of *Triphala*]
- Olenikov D.N., Kashchenko N.I., Chirikova N.K. (2015). *In vitro* bioaccessibility, human gut microbiota metabolites and hepatoprotective potential of chebolic ellagitannins: A case of Padma Hepaten formulation. *Nutrients.* 7, 8456–8477. [This paper discusses the gut microbiota and hepatoprotective potential of *Triphala*]

- Pan S.Y., Zhou S.F., Gao S.H., Yu J.L., Zhang S.F., Tang M.K., Sun J.N., Ma D.L., Han Y.F., Fong W.F., Ko K.M. (2013). New Perspectives on How to Discover Drugs from Herbal Medicines: CAM's Outstanding Contribution to Modern Therapeutics. *Evid. Based Complementary Altern. Med.* Article ID 627375. [This paper discusses about *Triphala*]
- Parasuraman S., Thing G.S., Dhanaraj S.A. (2014). Polyherbal formulation: Concept of ayurveda. *Pharmacogn. Rev.* 8(16), 73-80. [This paper discusses about *Triphala*]
- Parveen R., Shamsi T.N., Singh G., Athar T., Fatima S. (2018). Phytochemical analysis and in-vitro biochemical characterization of aqueous and methanolic extract of *Triphala*, a conventional herbal remedy. *Biotechnol. Rep.* 17, 126–136. [This paper discusses about *Triphala* constituents]
- Patel D.K., Kumar R., Laloo D., Hemalatha S. (2012). Diabetes mellitus: An overview on its pharmacological aspects and reported medicinal plants having antidiabetic activity. *Asian. Pac. J. Trop. Biomed.* 2, 411–420. [This paper discusses the antidiabetic properties of *Triphala*]
- Peterson C.T., Denniston K., Chopra D. (2017). Therapeutic Uses of *Triphala* in Ayurvedic Medicine. *J. Altern. Complement. Med. (New York, N.Y.)*, 23(8), 607–614. [This paper discusses about *Triphala*]
- Peterson C.T., Pourang A., Dhaliwal S., Kohn J.N., Uchitel S., Singh H., Mills P.J., Peterson S.N., Sivamani R.K. (2020). Modulatory Effects of *Triphala* and Manjistha Dietary Supplementation on Human Gut Microbiota: A Double-Blind, Randomized, Placebo-Controlled Pilot Study. *J. Altern. Complement. Med.* 26(11), Published Online. [This paper discusses the gastroprotective properties of *Triphala*]
- Pharmacy F., St P., Ake M., Thani P. (2016). HPLC-MS profiles and quantitative analysis of *Triphala* formulation. *BHST.* 14, 57–67. [This paper discusses the bioactive phytochemicals of *Triphala*]
- Phetkate P., Kummalue T., OrnRinthong P., Kietinun S., Sriyakul K. (2020). Study of the safety of oral *Triphala* aqueous extract on healthy volunteers. *J. Integr. Med.* 18(1):35-40. [This paper discusses the antidiabetic properties of *Triphala*]
- Phimarn W., Sungthong B., Itabe H. (2021). Effects of *Triphala* on Lipid and Glucose Profiles and Anthropometric Parameters: A Systematic Review. *J. Evid. Based. Integr. Med.* 26, :2515690X211011038. [This paper discusses the antidiabetic properties of *Triphala*]
- Pinmai K., Chunlaratthanabhorn S., Ngamkitidechakul C., Soonthornchareon N., Hahnvajjanawong C. (2008). Synergistic growth inhibitory effects of *Phyllanthus emblica* and *Terminalia bellerica* extracts with conventional cytotoxic agents: doxorubicin and cisplatin against human hepatocellular carcinoma and lung cancer cells. *World. J. Gastroenterol.* 14(10), 1491–1497. [This paper discusses the anti-cancerous properties of *Triphala*]
- Ponnusankar, S., Pandit S., Babu R., Bandyopadhyay A., Mukherjee P.K. (2011). Cytochrome P450 inhibitory potential of *Triphala*-A rasayana from ayurveda. *J. Ethnopharmacol.* 133, 120-125. [This paper discusses the pharmacological properties of *Triphala*]
- Poojary M.M., Vishnumurthy K.A., Adhikari A.V. (2015). Extraction, characterization and biological studies of phytochemicals from *Mammeasuriga*. *J. Pharma. Anal.* (5)3, 182-189. [This paper discusses modern medicine isolated from different medicinal plants]
- Pourmorad F., Hosseinimehr S.J., Shahabimajd N. (2006). Antioxidant activity, phenol and flavonoid contents of some selected Iranian medicinal plants. *Afr. J. Biotechnol.* 5, 11. [This paper discusses the antioxidant properties of *Triphala*]
- Prabhakar J., Balagopal S., Priya M.S., Selvi S., Senthilkumar M. (2014). Evaluation of antimicrobial efficacy of *Triphala* (an Indian Ayurvedic herbal formulation) and 0.2% chlorhexidine against *Streptococcus mutans* biofilm formed on tooth substrate: An in vitro study. *Indian J. Dent. Res.* 25, 475–479. [This paper discusses the oral protective and antimicrobial properties of *Triphala*]
- Prasad S., Srivastava S.K. (2020). Oxidative Stress and Cancer: Chemopreventive and Therapeutic Role of *Triphala*. *Antioxidants.* 9(1), 72. [This paper discusses the anti-cancerous properties of *Triphala*]
- Rajan SS, Antony S. (2008). Hypoglycemic effect of *Triphala* on selected non insulin dependent diabetes mellitus subjects. *Ancient. Sci. Life.* 27, 45–49. [This paper discusses the antidiabetic properties of *Triphala*]

- Rao M.M., Kar A.C., Bhattacharya P. (2004). A clinical study on the effect of Kankayanvati, Kaseesaditailavasti and *Triphala* Churna in the management of arsha (haemorrhoids). *J. Res. Ayurveda. Siddha*. 15, 9-21. [This paper discusses the therapeutic application of *Triphala*]
- Rasool M., Sabina E.P. (2007). Antiinflammatory effect of the Indian Ayurvedic herbal formulation *Triphala* on adjuvant induced arthritis in mice. *Phytother. Res.* 21, 889–894. [This paper discusses the antiinflammatory properties of *Triphala*]
- Rayudu V., Raju A.B. (2014). Effect of *Triphala* on dextran sulphate sodium-induced colitis in rats. *Ayu*. 35, 333–338. [This paper discusses the gastroprotective properties of *Triphala*]
- Reddy D.B., Reddy T.C., Jyotsna G., Sharan S., Priya N., Lakshmipathi V., Reddanna P. (2009). Chebulagic acid, a COX-LOX dual inhibitor isolated from the fruits of *Terminalia chebula* Retz., induces apoptosis in COLO-205 cell line. *J. Ethnopharmacol.* 124, 506–512. [This paper discusses the anti-cancerous properties of *Triphala*]
- Reddy V.R.C., Kumari S.V.R., Reddy B.M., Azeem M.A., Prabhakar M.E., Appa Rao A.V.N. (1990). Cardiotonic activity of the fruit of *Terminalia chebula*. *Fitoterapia*. 41(6), 517-525. [This paper discusses about *Terminalia chebula*]
- Rooban B.N., Lija Y., Biju P.G. et al. (2009). Vitex negundo attenuates calpain activation and cataractogenesis in selenite models. *Exp. Eye. Res.* 88(3), 575-582. [This paper discusses the eye protective properties of *Triphala*]
- Rugge M., Genta R. M., Di Mario F. (2017). Gastric Cancer as Preventable Disease. *Clin. Gastroenterol. Hepatol.* 15(12), 1833–1843. [This paper discusses the anti-cancerous properties of *Triphala*]
- Sabina E.P., Rasool M., VEDI M., Geethanjali A. (2013). Protective properties of traditional herbal formulation *Triphala* against D-Galactosamine induced hepatotoxicity in mice. *Int. J. Drug Dev. Res.* 5(2), 164-173. [This paper discusses the hepatoprotective properties of *Triphala*]
- Sabu M.C., Kuttan R. (2002). Anti-diabetic activity of medicinal plants and its relationship with their antioxidant property. *J. Ethnopharmacol.* 81, 155-160. [This paper discusses the antioxidant and antidiabetic properties of *Triphala*]
- Sandhya B., Thomas S., Isabel W., Shenbagarathai R. (2006). Ethnomedicinal Plants used by the Valaiyan Community of Pairanmalai Hills (Reserved Forest), Tamilnadu, India-A Pilot Study. *Afr. J. Tradit. Complement. Altern. Med.* 3(1):101-114. [This paper discusses about *Triphala*]
- Sandhya T., Lathika K.M., Pandey B.N., Mishra K.P. (2006a). Potential of traditional ayurvedic formulation, *Triphala*, as a novel anticancer drug. *Cancer. Lett.* 231, 206–214. [This paper discusses the anti-cancerous properties of *Triphala*]
- Sandhya T., Lathika K.M., Pandey B.N., Bhilwade H.N., Chaubey R.C., Priyadarsini K.I., Mishra K.P. (2006b). Protection against radiation oxidative damage in mice by *Triphala*. *Mutat. Res.* 609(1):17–25. [This paper discusses the anti-cancerous properties of *Triphala*]
- Sandhya T., Mishra K.P. (2006). Cytotoxic response of breast cancer cell lines, MCF 7 and T 47 D to *Triphala* and its modification by antioxidants. *Cancer. Lett.* 238, 304-313. [This paper discusses the anti-cancerous properties of *Triphala*]
- Saraphanchotiwitthaya A., Sripalakit P. (2015). Immunomodulatory Effect Of Different Proportions Of The Herbal Mixture In *Triphala* On Human T Lymphocytes (MOLT-4). *Int. J. Pharm. Pharm. Sci.* 7(7), 282-288. [This paper discusses the Immunomodulatory potential of *Triphala*]
- Sarkaki A., Farbood Y., Dolatshahi M., Mansouri S.M., Khodadadi A. (2016). Neuroprotective Effects of Ellagic Acid in a Rat Model of Parkinson's Disease. *Acta. Med. Iran.* 54(8), 494-502. [This paper discusses the Neuroprotective potential of *Triphala*]
- Saravanan S., Srikumar R., Manikandan S., Parthasarathy N.J., Devi R.S. (2007). Hypolipidemic effect of *Triphala* in experimentally induced hypercholesteremic rats. *YakugakuZasshi*. 127(2), 385-388. [This paper discusses the hypolipidemic potential of *Triphala*]
- Saxena D., Saha S.G., Saha M.K., et al. (2015). An in vitro evaluation of antimicrobial activity of five herbal extracts and comparison of their activity with 2.5% sodium hypochlorite against *Enterococcus*

faecalis. *Indian J. Dent. Res.* 26, 524–527. [This paper discusses the Oral health and antimicrobial potential of *Triphala*]

Saxena S., Lakshminarayan N., Gudli S., Kumar M. (2017). Anti bacterial efficacy of *Terminalia chebula*, *Terminalia bellirica*, *Embilica officinalis* and *Triphala* on salivary streptococcus mutans count—A linear randomized cross over trial. *J. Clin. Diagn. Res.* 11, ZC47–ZC51. [This paper discusses the Oral health and antimicrobial potential of *Triphala*]

Sen S., Sen S., Sharma S. (2017). *Triphala*: A Boon in Oral and Systemic Health. *J. Dent. Oral. Biol.* 2(1): 1024. [This paper discusses the oral health enhancing properties of *Triphala*]

Shakouie S, Eskandarinezhad M., Gasemi N., Milani A. S., Samiei M., Golizadeh, S. (2014). An in vitro comparison of the antibacterial efficacy of *Triphala* with different concentrations of sodium hypochlorite. *Iran. Endod. J.* 9(4), 287–289. [This paper discusses the antibacterial properties of *Triphala*]

Sharma D.K., Varshneya C., Mehta M. (2012). Total phenolic content and antioxidant activity of *Triphala* (an Ayurvedic formulation) and its constituents. *Am. J. Pharma Tech. Res.* 2, 458-465. [This paper discusses the antioxidant properties of *Triphala*]

Sharma S., Gupta M., Bhadauria R. (2014). Phytochemical variations in commercially available *Triphala* powder: A well knowndiatary supplement of Indian system of Medicine. *Res. J. Med. Plant.* 8(5), 214-222. [This paper discusses about different brand of *Triphala*]

Sharma S., Gupta M., Bhadauria R. (2015). Quality evaluation of commercially available *Triphala* powder: a renown dietary supplement of Indian system of medicines. *Qual. Assur. Saf. Crop.* 7(5), 599-611. [This paper discusses about safety evalutation of *Triphala*]

Shi Y., Sahu R.P., Srivastava S.K. (2008). *Triphala* inhibits both in vitro and in vivo xenograft growth of pancreatic tumor cells by inducing apoptosis. *BMC Cancer*, 8, 294. [This paper discusses the anti-cancerous properties of *Triphala*]

Shivakumar A., Paramashivaiah S., Anjaneya R.S., Hussain J., Ramachandran J. (2016). Pharmacognostic evaluation of *Triphala* herbs and establishment of Chemical stability of *Triphala* caplets. *Int. J. Pharma. Sci. Res.* 7(1), 244-251. [This paper discusses about safety evalutation of *Triphala*]

Singh D.P., Mani D. (2015). Protective effect of *Triphala* Rasayana against paracetamol-induced hepato-renal toxicity in mice. *J. Ayurveda. Integr. Med.* 6(3), 181-186. [This paper discusses about antioxidant activities and hepatoprotective properties of *Triphala*]

Singh P., Kakkar P., Singh R.L. (2016) Protective Effect of *Trigonella foenum-graecum* and *Foeniculum vulgare* Mature Leaf Against t-BHP induced Toxicity in Primary Rat Hepatocytes. *J. Exp. Food. Chem.* 2, 111. [This paper discusses about antioxidant activities]

Singh P., Vishwakarma S.P., Singh R.L. (2013). Evaluation of Antioxidant, Oxidative DNA Damage Protective and Antimicrobial Activities of *Foeniculum vulgare* Plant. *J. Med. Plant. Res.* 4(35), 2551-2563. [This paper discusses about antioxidant activities]

Singh P., Vishwakarma S.P., Singh R.L. (2014). Antioxidant, Oxidative DNA Damage Protective and Antimicrobial activities of *Trigonella foenum-graecum* plant. *J. Sci. Food. Agric.* 94(12), 2497-2504. [This paper discusses about antioxidant activities]

Singh P., Vishwakarma S.P., Singh U., Shukla M., Singh R., Singh R.K., Singh R.B., Wilson D.W., Singh R.L. (2012). Quantification and Evaluation of Antioxidant Activity of Some Bioactive Phytochemicals in Different Medicinal Plants. *Open. Nutraceuticals. J.* 5, 179-186. [This paper discusses the antioxidant properties of *Terminalia bellirica*]

Singh O.P., Singh R., Singh S.K., Singh U.S. (2005). Role of Kankayanvati, *Triphala* Churna and Kasishaditaila in the management of arsha (anorectal piles). *J. Res. Ayurveda Siddha.* 26, 59-65. [This paper discusses the Therapeutic application of *Triphala*]

Spector A. (1995). Oxidative stress-induced cataract: mechanism of action. *FASEB J.* 9(12), 1173-1182. [This paper discusses the antioxidant and eye care properties of *Triphala*]

- Srikumar R., Narayanaperumal J., Manikandan S., Govindarajulu S., Sheeladevi R. (2006). Effect of *Triphala* on oxidative stress and on cell-mediated immune response against noise stress in rats. *Mol. Cell. Biochem.* 283, 67-74. [This paper discusses the antioxidant and Immunomodulatory effect of *Triphala*]
- Srikumar R., Parthasarathy N.J., Manikandan S., Muthuvel A., Rajamani R., Sheeladevi R. (2007a). Immunomodulatory effect of *Triphala* during experimentally induced noise stress in albino rats. *J. Health. Sci.* 53(1), 142-145. [This paper discusses the Immunomodulatory effect of *Triphala*]
- Srikumar R., Parthasarathy N.J., Shankar E.M., Manikandan S., Vijayakumar R., Thangaraj R., Vijayananth K., Sheeladevi R., Rao U.A. (2007b). Evaluation of the growth inhibitory activities of *Triphala* against common bacterial isolates from HIV infected patients. *Phytother. Res.* 21(5), 476-480. [This paper discusses the antibacterial properties of *Triphala*]
- Srinagesh J., Krishnappa P., Somanna SN. (2012). Antibacterial efficacy of *Triphala* against oral streptococci: An in vivo study. *Indian J. Dent. Res.* 23, 696. [This paper discusses the antibacterial properties of *Triphala*]
- Srinagesh J., Pushpanjali K. (2011). Assessment of antibacterial efficacy of *Triphala* against mutans streptococci: A randomised control trial. *Oral. Health. Prev. Dent.* 9, 387-393. [This paper discusses the antibacterial properties of *Triphala*]
- Tabasco R., Sanchez-Patan F., Monagas M., Bartolome B., Moreno-Arribas M.V., Pelaez C., Requena T. (2011). Effect of grape polyphenols on lactic acid bacteria and Bifidobacteria growth: Resistance and metabolism. *Food. Microbiol.* 28(7), 1345-1352. [This paper discusses the intestinal microflora supporting properties of *Triphala*]
- Takauji Y., Miki K., Mita J., Hossain M.N., Yamauchi M., Kioi M., Ayusawa D., Fujii M. (2016). *Triphala*, a formulation of traditional Ayurvedic medicine, shows protective effect against X-radiation in HeLa cells. *J. Biosci.* 41(4), 569-575. [This paper discusses the radioprotective properties of *Triphala*]
- Tambekar D.H., Dahikar S.B. (2011). Antibacterial activity of some Indian ayurvedic preparations against enteric bacterial pathogens. *J. Adv. Pharm. Technol. Res.* 2, 24-29. [This paper discusses the antibacterial properties of *Triphala*]
- Tarasiuk A., Mosińska P., Fichna J. (2018). *Triphala*: current applications and new perspectives on the treatment of functional gastrointestinal disorder. *Chin. Med.* 39, 1-11. [This paper discusses the gastroprotective properties of *Triphala*]
- Thiagarajan R., Manikandan R. (2013). Antioxidants and cataract. *Free. Radic. Res.* 47(5), 337-345. [This paper discusses the antioxidant and eye protective properties of *Triphala*]
- Thomas S., Asokan S., John B., Priya G., Kumar S. (2017). Comparison of antimicrobial efficacy of diode laser, *Triphala*, and sodium hypochlorite in primary root canals: A randomized controlled trial. *Int. J. Clin. Pediatr. Dent.* 10, 14-17. [This paper discusses the oral protective properties of *Triphala*]
- Tiwari A.K. (2004). Antioxidants: New-generation therapeutic base for treatment of polygenic disorders. *Curr. Sci.* 86, 1092-1102. [This paper discusses the antioxidant properties of *Triphala*]
- Tsai C.F., Wu, J.Y., Hsu Y.W. (2019). Protective Effects of Rosmarinic Acid against Selenite-Induced Cataract and Oxidative Damage in Rats. *Int. J. Med. Sci.* 16(5), 729-740. [This paper discusses the eye protective properties of *Triphala*]
- Tsering J., Hu X., (2018). *Triphala* Suppresses Growth and Migration of Human Gastric Carcinoma Cells In Vitro and in a Zebrafish Xenograft Model. *Bio. Med. Res. Int.* 2018, Article ID 7046927. [This paper discusses the Antineoplastic properties of *Triphala*]
- Vadde R., Radhakrishnan S., Reddivari L., Vanamala J.K. (2015). *Triphala* extract suppresses proliferation and induces apoptosis in human colon cancer stem cells via suppressing cMyc/cyclin D1 and elevation of Bax/Bcl-2 ratio. *Bio. Med. Res. Int.* 2015:649263. [This paper discusses the anti-cancerous properties of *Triphala*]
- Vani T., Rajani M., Sarkar S., Shishoo C.J. (1997). Antioxidant Properties of the Ayurvedic Formulation *Triphala* and its Constituents. *Int. J. Pharmacogn.* 35(5), 313-317. [This paper discusses the antioxidant properties of *Triphala*]

- Variya B.C., Bakrania A.K., Patel S.S. (2016). *Emblca officinalis* (Amla): A review for its phytochemistry, ethnomedicinal uses and medicinal potentials with respect to molecular mechanisms. *Pharmacol. Res.* 111:180-200. [This paper discusses the various aspects of *Emblca officinalis*]
- Varma S.R., Sivaprakasam T.O., Mishra A., Kumar L.M., Prakash N.S., Prabhu S., Ramakrishnan S. (2016). Protective Effects of *Triphala* on Dermal Fibroblasts and Human Keratinocytes. *PLoSONE*. 11, e0145921. [This paper discusses the antioxidant properties of *Triphala*]
- Vemuri P.K., Dronavalli L., Nayakudugari P., Kunta A., Challagulla R. (2019). Phytochemical Analysis and Biochemical Characterization of *Terminalia chebula* Extracts for its Medicinal Use. *Biomed.Pharmacol. J.* 12(3), 1525-1529. [This paper discusses the various aspects of *Terminalia chebula*]
- Vousden K.H., Prives C. (2009). Blinded by the light: the growing complexity of p53. *Cell*. 137(3), 413–431. [This paper discusses the anti-cancerous properties of *Triphala*]
- Ward F.M., Daly M.J. (1999). Hepatic Disease. In: *Clinical Pharmacy and Therapeutics* (Walker R. and Edwards C. Eds.). Churchill Livingstone, New York, pp: 195-212. [This book discusses the hepatoprotective properties of *Triphala*]
- Whiteford H.A., Ferrari A.J., Degenhardt L., Feigin V., Vos T. (2015). The global burden of mental, neurological and substance use disorders: An analysis from the Global Burden of Disease Study 2010. *PLoS One*. 10, e0116820. [This paper discusses the stress reducing and neuroprotective properties of *Triphala*]
- Yadav S., Gite S., Nilegaonkar S., Agte V. (2011). Effect of supplementation of micronutrients and phytochemicals to fructooligosaccharides on growth response of probiotics and *E. coli*. *Biofactors*. 37, 58–64. [This paper discusses the intestinal gut microflora supporting properties of *Triphala*]
- Yang M.H., Vasquez Y., Ali Z., et al. (2013). Constituents from *Terminalia* species increase PPARalpha and PPARgamma levels and stimulate glucose uptake without enhancing adipocyte differentiation. *J. Ethnopharmacol.* 149, 490–498. [This paper discusses the antidiabetic properties of *Triphala*]
- Zhao Y., Wang M., Tsering J., Li H., Li S., Li Y., Liu Y., Hu X. (2018). An Integrated Study on the Antitumor Effect and Mechanism of *Triphala* Against Gynecological Cancers Based on Network Pharmacological Prediction and In Vitro Experimental Validation. *Integr. Cancer. Ther.* 17(3), 894-901. [This paper discusses the anti-cancerous properties of *Triphala*]
- Zhang X.J., He L.J., Lu Q., Li D.Y. (2016). Pharmacological activity of *Terminalia chebula*. *Zhongguo. Zhong. Yao. Za. Zhi*. 41(4):619-623. [This paper discusses the various aspects of *Terminalia chebula*]
- Zhang Y., Liu X., Gao S., Qian K., Liu Q., Yin X. (2018). Research on the Neuro-protective Compounds in *Terminalia chebula* Retz Extracts in-vivo by UPLC–QTOF-MS. *Acta. Chromatographica*. 30(3): 169–174. [This paper discusses the various aspects of *Terminalia chebula*]

Biographical Sketches

Pankaj Singh is presently working as Assistant Professor at Department of Biotechnology, Dr. Rammanohar Lohia Avadh University, Ayodhya, since 2019. He completed his master's degree in Biochemistry from Dr. Rammanohar Lohia Avadh University, Ayodhya, in 2007, and was awarded Research Fellowship under the UGC program of “Research Fellowship in Sciences for Meritorious Students” from March, 2008 to March 2013. He joined the Department of Biochemistry at Dr. Rammanohar Lohia Avadh University, Ayodhya, in 2008, and worked extensively on antioxidant and hepatoprotective activities of medicinal plants and has been awarded Ph.D. degree in 2014. He published twenty two research papers in peer-reviewed journals and eight book chapters published by international publishers such as Springer Nature and Elsevier. He participated in various national and international scientific conferences and symposia and presented 10 research papers. He has five years teaching experiences at graduate and post graduate levels and has guided six postgraduate students for his dissertation work. Dr. Singh also participated in four national training programmes related to molecular analysis, identification of phytochemicals and faculty development program. He has also worked as laboratory officer (Quality Assurance) at Thyrocare Technologies Limited, Mumbai.

Pankaj Kumar Tripathi is presently working as a Postdoctoral fellow at Institute of Plant Sciences, Agricultural Research Organization (ARO), Volcani Center, Rishon Lezion, Israel. He did his M.Sc in Biotechnology with first class from Dr. Ram Manohar Lohia Avadh University, Ayodhya and obtained his Doctoral degree in Botany from Sikkim University, Gangtok, Sikkim. His doctorate research was focused on the area of Parkinson's disease (PD) and its management by L-Dopa, which is a precursor to dopamine and is considered as gold standard in the management of PD and dystonia. He has been in research profession since 2008. He did his post Ph.D job as a Scientist at Patanjali Research Institute, Haridwar and as a Project Coordinator in the Centre of Excellence at Indira Gandhi National Tribal University. Dr. Tripathi has published several research papers in journals of repute and presented his research papers in many National and International Conferences. He has also completed many national level projects funded by DBT, CSIR, DST and MoTA. He has interest in biodiversity, taxonomy, molecular biology, plant tissue culture, ethnomedicines/ traditional medicines, bioactive compounds, natural products, drug target & drug development, genetics & plant breeding.

Ram Lakhan Singh is presently holding the position of Vice-Chancellor of Nilamber-Pitamber University, Medininagar, Jharkhand, India. Professor Singh held the position of Professor of Biochemistry and Coordinator, Biotechnology Programme at Dr. Rammanohar Lohia Avadh University, Ayodhya, India prior to joining this assignment. He also held positions of Head, Departments of Biochemistry and Environmental Science; Dean, Faculty of Science; Dean, Students' Welfare and Director, Institute of Engineering & Technology in the same University. He has 34 years of experience as teacher, researcher and academic administrator. His main areas of research are Clinical/Nutraceutical Biochemistry, Environmental Biotechnology and Toxicology. He published 88 research papers in National and International journals of repute. Professor Singh has written/edited nine books published by Springer-Nature, Elsevier and CRC, and contributed 19 chapters in various books published by International publishers. He is on the panel of experts in academic bodies and selection committees of various universities/government organizations and funding agencies. He has been honoured as Best Teacher by International Association of Lions Clubs in 1999. Professor Singh has been awarded IUTOX Senior Fellowship by International Union of Toxicology during XI International Congress of Toxicology at Montreal, Canada in 2007. He has been conferred with 'Shikshak Shree Samman' by Government of Uttar Pradesh in 2012. Professor Singh has been admitted to the Fellowships of the Society of Toxicology, India in 2011 and Academy of Environmental Biology, India in 2015.