WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.084
Volume 9, Issue 6, 643-661. Review Article ISSN 2277– 7105

PHARMACOLOGICAL EXPLORATION OF TERMINALIA BELLERICA ROXB.

Aiswarya Lakshmi A.G.*, Siju E.N., Vivek D., Minil M., Bijesh Vatakeel and Chaithanya K. P.

P. G. Department of Pharmacology, College of Pharmaceutical Sciences, Government Medical College, Kannur-670503, Kerala, India.

Article Received on
02 April 2020,

Revised on 23 April 2020,
Accepted on 13 May 2020,

DOI: 10.20959/wjpr20206-17578

***Corresponding Author**
Prof. Aiswarya Lakshmi A.G.
P. G. Department of Pharmacology, College of Pharmaceutical Sciences, Government Medical College, Kannur-670503, Kerala, India.

ABSTRACT

Terminalia bellerica Roxb. (Combretaceae) is one of the most commonly used plants in Indian traditional systems of medicine. The fruit rind is used in different preparations, for example, as one of the ingredients of "Triphala" (three fruits), used in Ayurveda for the treatment of fever, cough, diarrhea, dysentery, and skin diseases. It is a large deciduous tree found all over in Asia, mostly native to Sri Lanka. Traditionally, *T.bellerica* is used for treatment of various diseases such as conjunctivitis, asthma, migraine, baldness, constipation and weak eyesight. It contains various phytoconstituents such as glycosides, flavonoids, tannins, phenolic compound, amino acids and saponins which are responsible for various pharmacological activities. In this review article provides comprehensive information on pharmacognostic, phytochemical and pharmacological properties of *T. bellerica*, as a source for further research studies.

KEYWORDS: *Terminalia bellerica*, Beleric Myrobalan, Chemical constituents, medicinal properties.

INTRODUCTION

A large number of medicinal plants available in nature and an impressive number of modern drugs have been isolated from natural sources like plant, mainly based on their use in traditional medicine.[1] Exploring the healing power of plants is an ancient concept. For centuries people have been trying to alleviate and treat disease with different plant parts.[2]

The medicinal plants typically contain in mixtures of different chemical compounds that may act individually, additively or in synergy to improve health.[3] Whenever a cell's internal environment is perturbed by infections, disease, toxins or nutritional imbalance, mitochondria diverts electron flow away from itself, forming reactive oxygen species (ROS). In reactive nitrogen species (RNS), thus lowering oxygen consumption and medicinal plants are believed to be an important source of new chemical substances with potential therapeutic effects. The research into plants with alleged folkloric use as, therefore be viewed as a fruitful and logical research strategy in the search for new drugs.[4,5]

Ancient literature mentions the use of number of plants, plant preparations and their phytochemical constituents as medicines. The use of herbal medicine is increasing due to its safety, efficacy and therapeutic potential as compared to synthetic pharmaceutical products.[6] It is estimated that, in many developing countries, two third of the population is dependent on medicinal plants to meet primary healthcare needs. However, the potential of higher plants as a source of herbal medicine is unexplored. Therefore, there is a need for thorough literature search on some species to update the current state of knowledge and one such plant is *Terminalia bellerica.*

Terminalia bellerica commonly used in Ramayana preparation, made up of three myrobalan fruits, known as Triphala, which is important in Indian as well as Tibetan traditional medicines.[7] *Terminalia bellerica* also known as Beleric Myrobalan belonging to family Combretaceae.The chemical constituents isolated from various parts of this plant include Alkaloid, coumarin, flavones, steroids, tannins, glycosides, terpenoid, saponin.[8] *Terminalia bellerica* has been shown to possess multifarious medicinal properties such antibiofilm activity, antidepressant activity, antidiabetic activity etc.In this review article summerises the various biological activities of *Terminalia bellerica.*

Scientific classification[9,11]

Kingdom : Plantae

Division : Magnoliophyta

Class : Mangoliopsida

Order : Myrtales

Family : Combretaceae

Genus : Terminalia

Species : *Terminalia bellerica*

Synonyms[10]

Bahera, Baheda, Bibhitaki, Belleric Myrobalan, Bedda Nut Tree, Beach- Almond, Aksha, Karshaphala, Kalidruma, Bhutavasa, Kaliyugalaya.

Vernacular names[11]

Malayalam: Tannikka, Thanni, English: Belleric myrobalan, Hindi: Bahera, Baheda, haira, Bulla, Assam: Bhomora, Bhomra, Bhaira, Bauri, Hullach, Bengali: Bayada, Bahura, Gujarati: Bahedan, Bero, Behasa, Kannada: Tara kai, Santikayi, Yahela, Kashmiri: Babelo, balali, Malayalam: Tannikka, Thanni, Marathi: Baheda, Bhirda, Oriya: Bahada, Bhara, Punjabi: Bahera, Balela, Tamil: Thanrikkai, Kaattu-elupoe, Telugu: Thanikkaya, Tandra, Bahadrha, Urdu: Bahera.

Distribution and habitat[12]

It grows wild at an elevation of upto 2000m in wide variety of ecologies. It is native to Sri Lanka, India, Bangladesh, Bhutan, Thailand, China, Indonesia, Pakistan, Malaysia, Nepal, Cambodia and Vietnam. In India, it is commonly found in Madhya Pradesh, Uttar Pradesh, Punjab and Maharashtra.

Ecology: It is mostly found in monsoon forests, mixed deciduous forests or dry deciduous dipterocarp forests, associated with teak.

Biology: It flowers in the month of October-November and fruits in November-December. The tree sheds leaves in November with young ones appearing together with flowers.

Biophysical limits[12]

Altitude: 0-2000m

Mean annual rainfall: 900-3000 mm

Mean annual temperature: 22-28°C

Soil type: It grows well loamy fertile soil with good drainage.

Plant description[11,13]

It is large deciduous tree with the height of 50m and diameter of 30m with a rounded crown. It is branchless upto 20m. It is perennial and requires cold climate.

Bark: The outer bark is bluish or ashy-grey whereas innerbark is yellow in colour. The bark contains number of longitudinal cracks.

Leaves: Leaves are large, alternate, glabrous, with the dimension of 4-24cm x 2-11cm, mostly clustered at the twig ends. Young leaves are copper red in colour which turn into parrot green and later they become dark green. Leaf tip is narrowly pointed. Base of the leaf is rounded to cunate, rufous-serious.

Flowers: Flowers are simple, solitary and sessile. They are greenish white in colour usually appear along with new leaves having an offensive odour or strong honey like smell.

Fruit: It is light yellow in colour. It is drupe, globose or ovoid, densely velutinous or sericeous, 2-4 x 1.8-2.2 cm. It is slightly 5 ridged, 3cm across. It is one seeded and covered with minute pale pubescence.

Fig 1: Fruit.

Fig 2: Branches.

Fig 3: Plant as a whole.

Phytochemistry[11]

Compounds	Chemical constituents
Flavon[13,14,16]	7-hydroxy 3',4'(methylenedioxy)flavone, luteoline
Steroid[16,18,19]	β- sitosterol
Lignans[19]	Termilignan, thannilignin, anolignan B
Tannins[20,21]	Gallic acid, ellagic acid, methyl gallate, ethyl gallate,chebulagininc acid, chebulagic acid, hexahydroxydiphenic acid ester
Glycosides[16,18,19]	Fructose, sucrose, galactose, D-glucose, mannose, rhamnose
Terpenoid[19]	Belleric acid, chebulagic acid, arjungenin
Saponin[13]	Bellericoside and bellericanin
Cardenolide[17]	Cannogenol 3-O-β-galactopyranosyl-(1→4)-O-α-L-rhamopyranoside
Flavonol[15] Aglycones	Quercetine and kampferol
Flavonol Glycosides	Quercetin-3-O-[6''-α-L-rhamnopyranosyl]-(1→6)-β-D-glucopyranoside (rutin), quercetin-3-O-α-L-rhamnopyranoside, quercetin-3-O-β-D-glucopyranoside and kaempferol-3-O-β-Dglucopyranoside
Fatty acids present in oil	Palmitic acid, linoleic acid, stearic acid, myristic acid and oleic acid
Glycerides of fatty acids	Palmitooleolinolein, stearo-oleolinolein, palmitodiolein,stearodiolein, dioleolinolein and triolein

Ayurvedic properties[13]

- Rasa (taste) – Kashaya (astringent)
- Guna (qualities) – Rooksha (dry), Laghu (light to digest)
- Vipaka (taste conversion after digestion) – Madhura (sweet)
- Veerya (potency) – Ushna (hot)
- Effect on Tridosha – Balances Kapha and Pitta
- Bhedanam – Eases motion, has laxative action

• Antiplatelet activity

The ethanolic extract of *Terminalia belerica* showed very good antiplatelet activity. This study was conducted by isolated compound (Tb-01),ethanolic extract and aspirin, and tube no. 1 contains normal saline solution as blank.It was observed that, both the Tb-01 and ethanolic extract, at the different concentrations showed significant antiplatelet activity when compared with control group.[22]

• Antiimplantation activity

Pregnancy interceptive effect of the extracts of *T. bellirica* barks can be done as dueto the estrogenic nature of the plant. Benzene nd ethanol extract of *Termilalia bellirica* barks

administered orally in female albino rat from day1 to 7 of pregnancy.Regular development of all the events leading to antiimplantation, at least in rats and mice was chiefly under the direct command of estrogen-progesterone interplay at the cellular level and a slight disturbance in this hormonal balance may result in an unfavorable endometrial environment.[23]

• **Antispasmodic and bronchodilatory activity:**Aqueous-methanolic fruit extract of *Terminalia bellerica* shows antispasmodic and bronchodilatory activity.Antispasmodic and bronchodialatory activity were studied by determine the mechanism of action for the medicinal use of *T. bellerica* fruit in hyperactive gastrointestinal and respiratory disorders by invitro and invivo methods. It showed causes relaxation of spontaneous contractions. In guinea-pig ileum, it produced rightward parallel shift of acetylcholine-curve followed by non-parallel shift with the suppression of maximum response at higher doses.[24,25]

• **Anti-fungal activity:** Ethanol extract of *T. bellerica* fruit exhibited antifungal activity with the potential to inhibit drug resistant fungal strains. An investigation was conducted to determine the anti-fungal activity of ethanolic extract of *Terminalia bellerica* fruit against five clinical and five environmental isolates of *Cryptococcus neoformans.* Anticryptococal activity was evaluated by disc diffusion method. It was found that clinical isolates were more susceptible as compared to environmental isolates. Hence, the antifungal activity was proved with the potential to inhibit the drug resistant fungal strain.[26] The ethanolic extract obtained from the fruit of *Terminalia bellerica* was assessed for their antifungal activity against clinical and environmental isolates of *C neoformans*.[27]

• **Anti-salmonella activity:** A study was carried out to determine anti-salmonella activity of different extracts i.e., petroleum ether, chloroform, acetone, alcohol and water extracts of fruit of *T. bellerica*. Alcoholic and water extract of fruit of *T. bellerica* showed significant anti-salmonella activity. The phytochemicals of fruit contain mainly lignans(termilignan, thannilignan, anolignanB,hydroxy-3',4'flavan). Results suggested that aqueous extract exhibited bactericidal activity at higher concentration and bacteriostatic activity at low concentration.[28]

• **Anti-microbial activity:** A study was conducted to demonstrate the antimicrobial activity of methanol extract of fruit of *T. bellerica* against respiratory pathogens *T. bellerica* possess antimicrobial activity against respiratory pathogens and hence can be used for treatment of diseases caused by pathogens.[29] Another method was evaluated using agar well diffusion

method the bacterial and fungal isolates using aqueous, petroleum ether and chloroform extracts of *Terminalia bellerica* fruits. It was observed that aqueous extract exhibited significant activity against the tested bacterial and fungal isolates, compared with other extracts.[14] The antimicrobial activity was also proved by disc diffusion assay. Here the antimicrobial potential of different extracts of leaf and stem of *T. bellerica* collected from two different sites was investigated against five Gram positive, five Gram negative and four fungi. The MIC, MBC was also evaluated. The *T. bellerica* extracts showed more antibacterial activity than antifungal activity.[30]

• **Anti-oxidant activity**: The methanolic extract of fruit of *Terminalia bellerica* having mainly lignans, Tannins etc. A study deals with free radical scavenging activity and antioxidant potential of acetone extract of *T. bellerica* fruit was determined by *in-vitro* assays. Acetone extract was subjected to partitioning with ethyl acetate and water. Ethyl acetate fraction was found to be more effective as compared to crude acetone extracts in all anti-oxidant assays. Because it was polyphenolic rich fractions.[31] Antioxidant activity of Terminalia bellerica was also proved by the comparitive study done with *T.chebula, T.arjuna*. These were evaluated for total phenolic, flavonoid, and tannin content, and *in vitro* antioxidant potential with DPPH, ORAC, and FRAP assays.[27]

• **Anti-biofilm activity:** Ethanol extract of *T. bellerica* plant was checked for its activity against the oral plaque forming bacteria *Streptococcus* mutants. It showed strong activity against *Streptococcus* mutans causing inhibition of biofilm formation. Hence, the study indicated that *T. bellerica* can be used as antibiofilm agent.[32]

• **Anti-ulcer activity:** Anti-ulcer activity of ethanolic extract of *T. bellerica* fruit was determined in wistar rats by pylorus ligation and ethanol induced ulcer models. Ethanol extract showed inhibition of the gastric lesion induced by pylorus ligation induced ulcer and ethanol induced gastric ulcer along with reduction in free acidity and ulcer index as compared to control. Hence, it exhibits potential anti-ulcer activity.[33]

Terminalia bellirica as an anti-inflammatory agent using carrageenan-induced inflammation and antiulcer agent using ethanol-acid induced gastric mucosal injury model in the Swiss albino rats. The histopathological changes of paws and stomachs were analysed. Oral administration of the extracts doses demonstrated a significant reduction in the ethanol- acid-induced gastric erosion in all the experimental groups when compared to the control.[34]

A comparative study was done with aspirin induced, ethanol induced, cold restraint, pylorus ligated wistar rat. Treatment with *Terminalia belerica* methanolic extract further provided significant antiulcer protection.[35]

• **Anti-Alzheimer's activity:** Fruit of *T. bellerica* having antioxidant and acetylcholine esterase inhibitory properties. A comparative study was carried out using methanol extract of Triphala and its three major ingredients i.e., fruits of *Terminalia chebula, Terminalia bellerica* and *Emblica officinalis* for their acetylcholinestrase inhibitory properties.[36]

• **Antihypertensive activity:** The crude extract of Terminalia bellerica fruit which tested positive for flavonoids, sterols and tannins induced a dose-dependent fall in the arterial BP of rats under anaesthesia. In isolated guinea-pig atria, inhibition of force and rate of atrial contractions noted. In rabbit thoracic aorta, relaxation was observed after the induction of contractions which was induced by phenylephrine.[37]

• **Anti-atherogenic activity:** Its an in vitro study, anti-atherogenic effect of *T.bellerica* was investigated by using hot water extract of *T. bellerica* fruit on low-density lipoprotein oxidation and inflammation on macrophages. Fruit of *T. bellerica* mainly contain lignans, Tannins, terpinoind, saponin. It showed DPPH radical scavenging activity and 15-lipoxygenase inhibitory activity along with significant *invitro* inhibition of free-radical induced LDL oxidation as compared to solvent control. The results indicate that *T. bellerica* extract had *in-vitro* inhibitory effects on LDL oxidation and macrophage inflammatory response. Hence, it can be used *in-vivo* to inhibit atherosclerosis plaque progression.[38]

• **Immunomodulatory effect:** Methanolic extract of *Terminalia bellerica* fruit showed stimulation of mocrphage phagocytosis through the production of superoxide and acid phosphatase. Fruit of *T. bellerica* mainly contain lignans, Tannins, terpinoind, saponin. Hence, the mouse immune system, specifically *in-vitro* cellular and humoral immune response was affected by methanol extract of *Terminalia bellerica* making it useful for the treatment of human immune mediated diseases.[39]

The another study is aimed to evaluate the Immunomodulatory activity of ethanolic extract of *T. bellirica* in mice. The ethanolic extract of fruit and bark of T.bellerica having immunomodulatory activity of its phytochemical constituents are alkaloid, coumarin, flavon, steroids etc. Its immunomodulatory activity was carried out by testing delayed type

hypersensitivity (DTH) reaction, phagocytic index, cyclophosphamide induced neutropenia and relative organ weight.[40]

• **Wound healing activity:** Fruit paste of *T.bellerica* was taken for wound healing activity..A study was conducted to evaluate the wound healing activity of ethanol extract of *Terminalia bellerica* fruit used in the form of ointment on excision and incision wound model. It exhibited greater wound healing contracting ability as compared to standard.[41]

• **Antifertility activity:** Adult male rats were administered with Benzene and ethanol extracts of *Terminalia bellerica* bark were administered orally for 50days. Biochemical estimation was done after dissecting and weighing epididymis and vasdeferens. The results indicated that the non-availability of androgens in rats treated with *Terminalia bellerica* bark extract.[42]

The sperm motility of cauda epididymis and sperm count of cauda epididymis and testis declined significantly leading to negative fertility test was occurred, while treating with the fruit extracts of *T. belerica* was fed orally to male albino rats for 60 days. The reproductive organs were decreased.[43]

• **Anti-diarrhoeal activity:** An investigation was carried out to determine the anti-diarrhoeal effect of aqueous and ethanolic extract of *Terminalia bellerica* fruit pulp at the different doses were used in castor oil induced diarrhoea, PGE2 induced enter pooling and gastrointestinal motility test. Comparison of percentage protection in these models revealed that the extracts have more prominent anti secretory effect than the reduction in gastrointestinal motility.[44]

• **Anti-cancer activity:** The whole plant of *T.bellerica* having anticancer activity. This contain alkaloid, coumarin and flavone, steroids etc. A comparative study was performed to determine *in-vitro* anti-cancer and antioxidant effects as well as total phenolic contents of five different extracts of *Terminalia bellerica* leaves results that petroleum ether extract exhibited the highest anti-cancer activity.[45]

P. emblica and *T. bellerica* extracts demonstrated growth inhibitory activity, with a certain degree of selectivity against the two cancer cell lines tested. A549 and HepG2 cells were taken for the test.[46]

• **Anti-plasmodial activity**: The whole plant part of *T.bellerica* contain alkaloids, coumarin, flavone, steroids etc. All plant extracts showed antimalarial activity. Antiplasmodial activity and cytotoxicity of water extract of *Phyllanthus emblica* Linn, *Terminalia bellerica* Retz and *Terminalia bellerica* (Gaetzertn) Roxb was evaluated by *in-vitro* and *in-vivo* studies. *Terminalia bellerica* showed highest *in-vitro* antiplasmodial activity compared with other plants. All plant extracts showed *in-vivo* antiplasmodial activity with good suppression activity in standard 4-day suppressive test on *P. berghei* infected mice.[47]

• **Anti-diabetic activity:** The fruit of *T. bellerica* mainly contain lignans(termilignan, thannilignan, methylenedioxy flavan, anolignan B), Tannins (Gallic acid, Ellagic acid, Methyl gallate, Ethyl gallate, Chebulagic acid, Chebulaginic acid, Hexahydroxydiphenic acid ester), terpinoind, saponin. A study was carried out to isolate compound from the fruit rind of *Terminalia bellerica* possessing anti-diabetic activity. Gallic acid was isolated from *Terminalia bellerica* by bioassay-guided fractionation. A significant dose-dependent reduction in plasma glucose level was observed.[47]

T. bellirica aqueous extract stimulated basal insulin output and potentiated glucose-stimulated insulin secretion concentration-dependently in the clonal pancreatic beta-cell line, BRIN-BD11.[48]

The antioxidant and hypoglycemic activity of methanolic extracts of the leaves of *Terminalia arjuna*, *T. bellerica*, and *T. chebula*. were evaluated for total phenolic, flavonoid, and tannin content, and *in vitro* antioxidant potential with DPPH, ORAC, and FRAP assays. The extracts' hypoglycemic activities were evaluated by hypoglycemic screening and an oral glucose tolerance test (OGTT) in normal rats.[49]

• **Hepatoprotective activity:** The whole aerial part of T.bellerica extract contain alkaloid, flavone, coumarin, steroids etc. Ethyl acetate extract of *T.bellerica* aerial parts was administered to BALB/CN mice, once a day for two consecutive days followed by carbon tetrachloride intoxication. It significantly ameliorated hepatic necrosis along with decreased expression of oxidative stress biomarkers, 4-hydroxynonenal (4-HNE) and 3-nitrotyrosine (3-NT) and restored P450 2E1 (CYP2E1) expression. Hence, results indicate that *T. bellerica* possess hepatoprotective activity.[50]

In this study, iron overload liver injury induced in mice and ameliorating effect of T.bellerica was studied. Iron overload was induced by intraperitoneal administration of iron-dextran. Treatment with different doses of methanolic extract of *T.bellerica*(TBME) showed dose dependent reduction in liver iron.[51]

.

Hepatoprotective activity of the ethanolic and aqueous extracts of Terminalia belerica Roxb. was studied in wistar rats using the ethanol-induced liver hepatotoxicty. Ethanol administration resulted in significant elevation of physical parameters, biochemical parameters. Pretreatment with silymarin, ethanolic extract of *Terminalia belerica* (ALTB) and aqueous extract of *Terminalia belerica* (AQTB) significantly prevented the physical and biochemical changes induced by these hepatotoxins. Histopathology of liver confirmed our finding as the treatment with the extracts resulted in minor liver cell damage compared to toxic control group. The hepatoprotective effect offered by ALTB was found to be significantly greater than AQTB and standard group.[52]

• **Anti-helminthic activity:** A study was conducted to evaluate the anti-helminthic potential of ethanolic and aqueous extract of *Terminalia bellerica* fruit pulp at various concentrations. And here using *Phesentia posthuma* as test worms. Various bioassay methods were used. Hence, it was confirmed that *Terminalia bellerica* fruit possess anti-helminthic activity and further studies can be carried out to isolate active principle responsible for this activity.[53]

Anthelmintic activity of aqueous and ethanolic extracts of *Terminalia belerica* fruit, *Boerrhavia diffusa* leaf and *Saxifraga granulata* root against *Pheretima posthuma* and *Eisenia foetida*. The study indicated significant anthelmintic activity of aqueous as well as ethanolic extracts of *Terminalia belerica* and *Boerrhavia diffusa*.[54]

• **Anti-depressant activity:** An investigation was carried out to study the anti-depressant activity of aqueous and ethanolic extracts of *Terminalia bellerica* fruits in Swiss young male albino mice using forced swim test (FST) and tail suspension test (TST). Both the extracts were administered orally for 10 successive days. Hence, both the extracts exhibited significant anti-depressant-like effect in mice by interaction with adrenergic, dopaminergic and serotonergic systems.[55]

• **Analgesic and antipyretic activity:** Acetic acid induced writhing, Eddy's hot plate method and brener's yeast induced fever models in mice and rats were the experiments to investigate

the analgesic and antipyretic activities of ethanolic and aqueous extract of *Terminalia bellerica* fruits. This experiments observed that both the extract showed a significant decrease in the number of writhes in acetic acid induced writhing and increase in licking time to heat stimuli in hot plate method. There was a significant inhibition of elevated body temperature by both extracts as compared to the corresponding control group. Hence, results indicate that the ethanolic and aqueous extract possessed significant analgesic and antipyretic activities.[56]

• **Cytogenetical effect:** A study was conducted to demonstrate cytogenetical effects of mother tincture of *Terminalia bellerica* fruit at different concentrations on the root meristem of *Viciafoba* to determine the clastogeneic potential. Various clastogenic abnormalities were observed. The mother tincture of *Terminalia bellerica* acts as stathmokinetic agent, since its effects were prominent on the spindle. Hence, this study reveals that injudicious use of mother tincture of *Terminalia bellerica* may lead to genetic deformities in bio-organisms which are safe with no potential side effects.[57]

The fruits of *Terminalia bellirica* (Gaertn) Roxb., widely used in traditional medicine, were evaluated for antibacterial activity against multidrug-resistant (MDR) bacteria, antioxidant activity and cytotoxicity. The minimum inhibitory concentration (MIC) was determined using an agar dilution method. The radical scavenging activity of six antibacterial extracts was screened against 2,2′-diphenyl-2-picrylhydrazyl (DPPH). Results indicate that T. bellirica fruit is a potential source for developing broad-spectrum antibacterial drugs against MDR bacteria, which are non-toxic to mammalian cells and impart health benefits by high antioxidant activity.[58]

• **Antiaxiety effect:** The objective of this study was to evaluate the attenuation of anxiety on acute administration of aqueous extract of *Terminalia belerica* fruit pulp (AETBFP) by using elevated plus maze test and dark and light arena models. Significant reduction in anxiety was noted. Our study reveals that AETBFP at a dose of has significant attenuation of anxiety in Swiss albino mice.[59]

• **Anti HIV activity:** A study investigated for extract the compound having antiHIV,anti malarial and anti fungal activities. The compounds containing in the ethanolic fruit extract of *T.bellerica* Compounds1-4 **(**termilignan (1) and thannilignan (2), together with 7-hydroxy-3□,4□-(methylenedioxy)flavan (3) and anolignan B (4).)obtained from Terminalia belerica were examined for anti-HIV-1 activity using MT-4 cells as infected cells.[60]

• **Coughs, Spleen, Gastrointestinal Disorders, Clear bowels, Flatulence, Dysentery:** Fruits are soaked overnight in water followed by drinking the water the following morning on an empty stomach.[61]

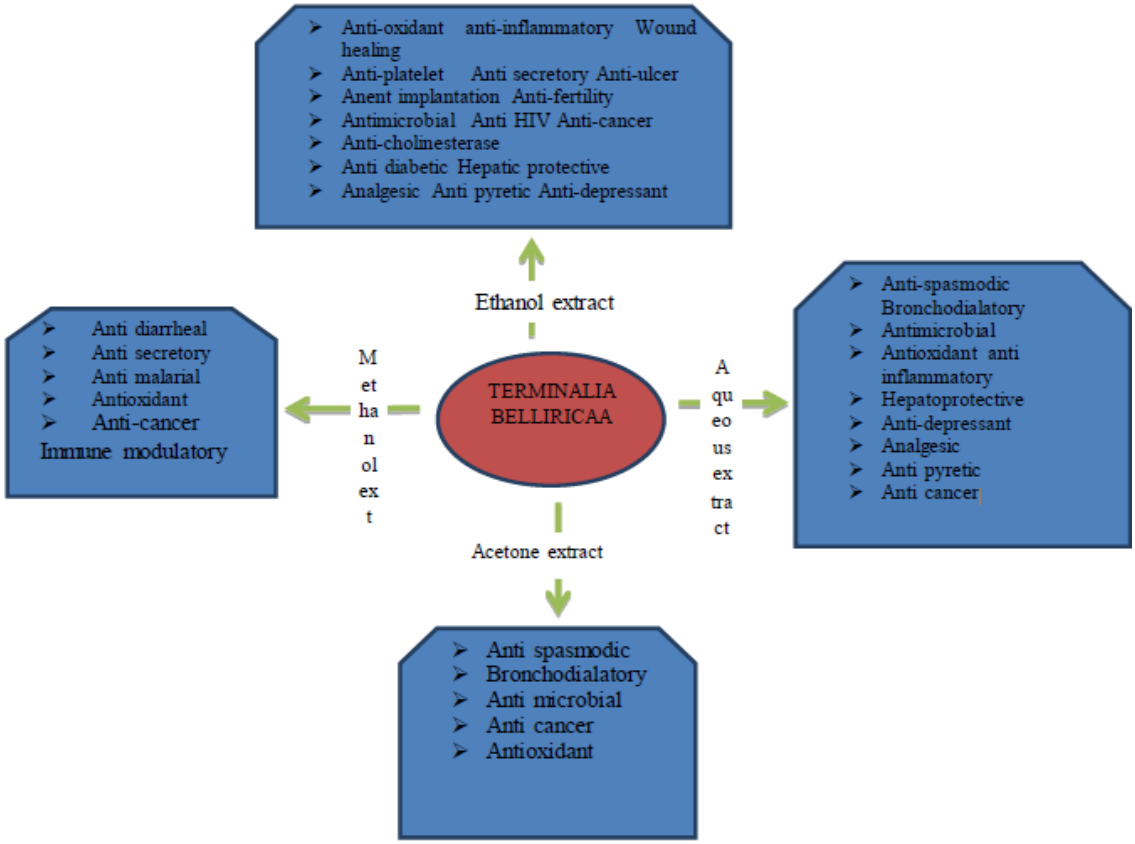

Fig 4: Pharmacological activities of *Terminalia Chebula.*

CONCLUSIONS

Therefore, there is a need for thorough literature search on some species to update the current state of knowledge and one such plant is *Terminalia bellerica.*

The analgesic, antipyretic and antiplatelet activities of alcohol extracts of *T. bellirica* were evident from various studies. Anti-fertility and anti-implantation effect proved by its oestrogenic effect investigations in albino mice. The aqueous alcoholic extract showed promising broncho dialatory effect by effectively controlling spasm. Various extracts of its fruit possess amti cancer activity, although maximum effect produced by pet.ether extract. The fruit and bark extract possess significant immunomodulatory effect, may be due to constituents as alkaloid, coumarin, flavon, steroids etc. The extensive antimicrobial effects include anti-bacterial, anti-fungal, anti-protozoa, anthelmintic, anti-salmonella effects.

Effective DPPH scavenging proved its invitro antioxidant effects, which may be due to high polyphenol contents present in it. The fruit extract also possess marked anti-hypertensive, hypolipidemic and amti arteriosclerotic effects in various *in vivo* cardiovascular experiments. The whole aerial part of *T.bellerica* extract contain alkaloid, flavone, coumarin, steroids etc and its thyl acetate extract showed significant hepatoprotective activity.

The *T bellirica* is a rich source of beneficial phytoconstituents, which are responsible for such valuable therapeutic effects s mentioned above, though it is still unexplored. So the current review provides comprehensive information on pharmacognostic, phytochemical and pharmacological properties of *T. bellerica*, as a source for further research studies which are beneficial to mankind.

REFERENCES

1. Siju, E. N., Jolly Samu, Minil M and Rajalakshmi G.R., 2015, In vitro Antioxidant activity of *Myxopyrum Smilacifolium* Blume. Asian Journal of Pharmaceutical and clinical Research, 2015; 8(3): 119-121.
2. Jolly Samu, Siju E. N. Minil M and Rajalakshmi G.R., 2015, In vitro Anti-inflammatory activity of *Myxopyrum Smilacifolium* Blume. World Journal of Pharmacy and Pharmaceutical Sciences, 2014; 3(6): 1822-1828.
3. E. N. Siju, Rajalakshmi G.R., M.KPoornima, M. K. Anusha.M.Minil. N. Hariraj and Rahul K. Ant proliferative properties of Leaf Extract of *Hopea ponga* Mabberly. International Journal of Pharmacological Research, 2017; 7(02): 37-42.
4. E. N. Siju, Sheeba Damodar, Dr. Rajalakshmi G.R., Amina Ali, Anu K.R. and Rahul K. In vitro Antioxidant and antidiabetic activity of hydroalcoholic extract of *Plumeria Pudica JACQ*. International Journal of Phytopharmacology, 2017; 8(1): 31-40.
5. Siju,E. N., Anusha K.V., Fairuza MKC, Kuttor DS, Minil M and Rajalakshmi G.R, In virto study of anti inflammatory activity of *Albizia Julibrissin*. Int J Res Pharm Sci, 2014; 4(2): 24-26.
6. Abraham A, Mathew L, Samuel S.Pharmacognostic studies of the fruits of Terminalia bellerica(Gaertn) Roxb. J Pharmacognostic Phytochemistry, 2014; 3(2): 45-52.
7. Kamali S H, Khalaj A R, Shirin H R, Esfehani MM, Kamalinejad M, Larijani B A. Systemic review of the antioxidant anti-diabetic, and anti-obesity effect and safety of triphala herbal formulation.Journal of Medicinal Plants Research, 2013; 7(14): 831-844.

8. Diab K A, Guru S K, Buhushans, axena A K.In vitro anticancer activities of Anogeissus latifolia, Terminalia bellerica, Acacia catechu and Moringa oleiferna Indian Plants. Asian Pac J cancer Prev, 2015; 16(15): 6423-6428.
9. https://www.mdidea.com/products/proper/proper06001.html
10. Kadian R, Parle M, Yadav M. Therapeutic potential a phytopharmacology of *Terminalia bellerica*. WJPPS, 2014; 3(10): 804-19.
11. https://www.easyayurveda.com/2013/01/13/bibhitaki-baheda-terminalia-bellirica-uses-ayurveda-details/html
12. Saleha Akter, Taslima Begum, Rayhana Begum, Tamanna Sharmin Tonny, Mousumi Yasmin, Sumsunnahar Shifa, Farzana Afroze and Faruquzzaman: phytochemical analysis and investigation of anti-inflammatory and anti-ulcer activity of *Terminalia bellirica* leaves extract IJP, 2019; 6(2): 54-65.
13. Meena AK, Yadav A, Singh U, Singh B, Sandeep, Kiran, Rao MM. Evaluation of physiochemical parameters on the fruit of *Terminalia Belerica* Roxb. Int. J. Pharm. and Pharma. Sci, 2010; 2(2): 97-99.
14. Devi PN, Kaleeshwari S, Poonkothai M. Antimicrobial Activity and Phytochemical Analysis of fruit extract of *Terminalia Bellerica*. Int J Pharm Pharm Sci, 6(5): 639-642.
15. Yadav RNS,Agarwal M.Phytochemical analysis of some medicinal plants. Journal Phytology, 2011; 3(12): 10-14.
16. Saroya AS. Herbalism phytochemistry and Ethanopharmacology, Science Publishers.1st edition, 2011; 357-361.
17. Mallik J, Das P, Karon B, Das S. A review on phytochemistry and pharmacological activity of *Terminalia bellerica.* Int. J. of drug formulation and res, 2012; 3(6): 1-7.
18. Indian Herbal Pharmacopoeia. Revised New Edition., Published by Indian Drug Manufacturer's Association, Mumbai, 2002; 429-438.
19. Singh A. Medicinal Plants of the World, Published by Mohan Primlani for Oxford and IBH Co. Pvt, New Delhi, 2006; 26.
20. Saxena V, Mishra G, Saxena A, Vishwakarma KK.A Comparative Study on Quantitative Estimation of Tannins in *Terminalia Chebula*, *Terminalia Belerica*, *Terminalia Arjuna* and Saraca indica using spectrophotometer. Asian J Pharm Clin Res, 2013; 6(3): 148-9.
21. Gangadhar M, Patil B, Yadav S, Sinde D. Isolation and characterization of gallic acid from *Terminalia Belerica* and its effect on carbohydrate regulatory system in vitro. Int. J. res. Ayur. and Pharm, 2011; 2(2): 559-62.

22. Vaseem A Ansari, Muhammad Arif Md, Sarfaraj Hussain, H H Siddiqui, R K Dixit. New 4'– substituted benzoyl–*β*–D glycoside from the fruit pulp of *Terminalia belerica* with antiplatelet and anti-oxidant potency. Integrative medicine research, 2016; 5(4): 317-323.
23. .Vishwanatha, S.Satishagouda, J.Sharangouda Patil, B.Saraswati Patil. Anti-implantation activity of *Terminalia bellirica* bark extracts in female albino rats. Indian J, 2009; 3(4): 257-260.
24. Gilani AH, Khan AU, Ali T, Ajmal S. Mechanisms underlying the antispasmodic and bronchodilatory properties of *Terminalia bellerica* fruit. Ethnopharmacol, 2008; 116(3): 528-38.
25. Anwarul Hassan Gilani, Arif-Ullah Khan, Tuba ali, Saad Ajmal. Anti-Spasmodic and Bronchodilatory Properties of Terminalia belerica Fruit, Journal of Ethnopharmacology, 2008; 11(6): 528-538.
26. Valli S, Shankar GS. *Terminalia bellerica*-A promising challenge to cryptococcosis. Int. J. of Pharmaceutical Res. and Bio-Science, 2013; 2(5): 154-69.
27. Renu Kadian, Milind Parle, Monu Yadav. Therapeutical potential and phytopharmacology of *Terminalia bellerica*, 2014; 3(10): 804-819.
28. Madani A, Jain S. Anti-Salmonella activity of *Terminalia belerica*: *In vitro* and *in vivo* studies. Indian J Exp Biol, 2008; 46(12): 817-21.
29. Sabnis S. Antimicrobial efficacy of *Terminalia bellerica* against virulence factors of respiratory pathogens. Int. J Curr. Microbiol & Appl Sci, 2014; 3: 215-21.
30. Chanda S, Menpara D, Desai D, (2013). Antimicrobial Activity of *Terminalia bellerica* Leaf and Stem Collected from Two Different Sites. American J. of Phytomedicine and Clinical Therapeutics, 2013; 1(9): 721-33.
31. Guleria S, Tiku AK, Rana S. Antioxidant activity of acetone extract/fractions of *Terminalia bellerica* Roxb. fruit. Indian J Biochem Biophys, 2010; 47: 1106.
32. Yadav S, Singh S, Sharma P, Thapliyal A, Gupta V. Antibiofilm Formation Activity of *Terminalia bellerica* Plant Extract Against Clinical Isolates of *Streptococcus mutans* and *Streptococcus sobrinus*: Implication in Oral Hygiene. Int. J. of Pharmaceu. & Bio. Arch, 2012; 3(4): 816-21.
33. Choudhary GP. Anti-ulcer activity of the ethanolic extract of *Terminalia belerica* Roxb. Int. j. pharm. Chem. Boil. sci, 2012; 1(4): 1293-7.
34. Saleha akter, Taslima begum, Rayhana begum, Tamanna sharmin tonny, Mousumi yasmin, Sumsunnahar shifa, Farzana afroze and faruquzzaman. phytochemical analysis

and investigation of anti-inflammatory and anti-ulcer activity of terminalia bellirica leaves extract. Ijp, 2019; 6(2): 54-65.

35. Hitesh Jawanjal, Mithun S. Rajput, Purti Agrawal, and Vikramsingh Dange. Pharmacological Evaluation of Fruits of *Terminalia belerica* Roxb. for Antiulcer Activity. Journal of Complementary and Integrative Medicine, 2012; 9(1): 1-10.
36. Nag G, De BR. Acetylcholinesterase inhibitory activity of *Terminalia chebula, Terminalia bellerica* and *Emblica officinalis* and some phenolic compounds. Int J Pharm Pharm Sci, 2011; 3(3): 121-4.
37. Khan AU, Gilani AH. Pharmacodynamic Evaluation of *Terminalia belerica* for its Anti Hypertensive Effect. J.of Food and Drug Analysis, 2008; 16: 614.
38. Tanaka M, Kishimoto Y, Saita E, Suzuki-Sugihara N, Kamiya T, Taguchi C *et al*. *Terminalia bellirica* Extract Inhibits Low-Density Lipoprotein Oxidation and Macrophage Inflammatory Response *in Vitro*.Antioxidants, 2016; 5(2): 20.
39. Saraphanchotiwitthaya A, Sripalakit P, Ingkaninan K. (2008). Effects of *Terminalia bellerica* Roxb. methanolic extract on mouse immune response in vitro. Maejo Int. J. of Sci. and Tech, 2008; 2(2): 400-7.
40. Mudagal Manjunatha, Hiral Bhalodiya, Md. Immunomodulatory Activity of Terminalia Bellirica Extract in MICE, 2011; 2(1): 103-108.
41. Choudhary GP. Wound healing activity of the ethanol extract of *Terminalia bellirica* Roxb. fruits. NPR, 2008; 7(1): 19-21.
42. Patil JS, Satishagouda S, Vishwanatha T, Patil BS.Effect of *Terminalia Bellirica* Barks xtracts on Activities of Accessory Reproductive Duct in Male Rats. Int. J. of Pharmaceutical Sci. Rev. and Res, 2010; 1(2): 75-78.
43. Venkatesh V, Sharma JD, Kamal R. A Comparative Study of Effect of Alcoholic Extracts of *Sapindus emarginatus, Terminalia belerica, Cuminum cyminum* and *Allium cepa* on Reproductive Organs of Male Albino Rats. Asian J. Exp. Sci, 2002; 16(1&2): 51-63.
44. Kumar B, Divakar K, Tiwari P, Salhan M, Goli D. Evalution of Anti-Diarrhoeal Effect of Aqueous And Ethanolic Extracts of Fruits Pulp of *Terminalia belerica* In Rats.Int. J. of Drug Develop. and Res, 2010; 2(4): 769-79.
45. Hanem Awad M, Fathalla Ayoob A, Mohamed Abdalla M. Evaluation of Total Phenol, Anticancer and Antioxidant Properties by Different Extracts of *Terminalia Belerica* Roxb. Leaves: An *In Vitro* Analysis. RJPBCS, 2015; 6(3): 360-67.
46. Pinmai K, Chunlaratthanabhorn S, Ngamkitidechakul C, Soonthornchareon N, and Hahnvajanawong C. 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, 2008; 14(10): 1491-97.

47. Pinmai K, Hiriote W, Soonthornchareonnon N, Jongsakul K, Sireeratawong S,Tor-Udom S. *In vitro* and *in vivo* antiplasmodial activity and cytotoxicity of water extracts of *Phyllanthusemblica*, *Terminalia chebula*, and *Terminalia bellerica*. J Med Assoc Thai, 2011; 23; 93(12): 120.
48. Violet Kasabri, Peter R. Flatt1 and Yasser H. A. Abdel-Wahab. Terminalia bellirica stimulates the secretion and action of insulin and inhibits starch digestion and protein glycation in vitro. British Journal of Nutrition, 2010; 103: 212–217.
49. Arya A, Nyamathulla S, Noordin MI, Mohd MA. Antioxidant and Hypoglycemic Activities of Leaf Extracts of Three Popular *Terminalia* Species. E-J. of Chem, 2012; 9(2): 883-92.
50. Rashed K, Potočnjak I, Giacometti J, Škoda M,Domitrović R. *Terminalia bellerica* aerial parts ethyl acetate extract exhibits antioxidant, anti-inflammatory and antifibrotic activity in carbon tetrachlorideintoxicated mice. J Funct Foods, 2014; 8: 319-30.
51. Hazra B, Sarkar R, Mandal N. (2012). Protection of *Terminalia bellirica Roxb.* Against Iron Overload Induced Liver Toxicity: An Account of its Reducing and Iron Chelating Capacity. American J. of Pharmacology and Toxicology, 2012; 7(3): 109-22.
52. Ritesh jain, K. Nandakumar, Vishal Srivastava,Santosh Kumar Vaidya, Shailesh Patet, Pradeep Kumar. Hepatoprotective actvity of ethanolic and aqueous extract of *Terminalia belerica* in rats. *Pharmacologyonline*2, 2008; 411-427.
53. Kumar B, Kalyani D, Hawal LM, Singh S. *In vitro* anthelmintic activity of ethanolic and aqueous fruit extract of *Terminalia belerica*. J Pharm Res, 2010; 3(5): 1061-2.
54. Kulkarni CG, Lohar BN, Jadhav ST, Salunkhe SS. Evaluation of Antihelmintic Axtivity of Indian Herbs. Int. J. of Pharmacy, 2014; 4(1): 357-62.
55. Dhingra D, Valecha R. Evaluation of antidepressant-like activity of aqueous and ethanolic extracts of *Terminalia bellirica*Roxb. fruits in mice. Indian J Exp Biol, 2007; 45(7): 610-6.
56. Sharma US, Sharma UK, Singh A. Screening of *Terminalia bellirica* fruits extracts for its analgesic and antipyretic activities. Jordan j. boil, Sci. 2010; 3(3): 121-4.
57. Asthana M, Kumar A, Sharma S. Cytogenetical Effects of *Terminalia bellerica*, Roxb. on Root Meristem of Viciafaba. Adv. Biores, 2011; 2(1): 174-77.

58. Akhlesh Singhal, Govind Nayak, Ashok Budhwani and Ahsish Singhai.1,1- diphenyl, 2-picryl hydrazyl radical scavenging activity of aqueous extract of Terminalia belerica bark, 2009; 25(3): 787-790.
59. Chandrashekar R, Manohar V. R., Poovizhi Bharathi R, Mohandas Rai. Attenuation of anxiety on acute administration of aqueous extract of *Terminalia belerica* fruit pulp in Swiss albino mice. IJBCP, 2017; 6(2): 303-307.
60. Raghavan Valsaraj, Palpu Pushpangadan,Ulla Wagner Smitt,Anne Adsersen, SøreBrøgger Christensen,Archibald Sittie, Ulf Nyman, Claus Nielsen,and Carl Erik Olsen. New Anti-HIV-1, Antimalarial, and Antifungal Compounds from *Terminalia bellerica. J. Nat. Prod*, 1997; 60: 739-742.
61. Das PR, Tabibul Islam Md, SaleHin Bin Mahmud ASM, Kabir MH, Ehasanul Hasan Md, Khatun Z., Mahbubur Rahman Md, Nurunnabi Md., Khatun Z, Lee Y, Jahan R, Rahmatullah M. An ethnomedicinal survey conducted among the folk medicinal practitioners of three villages in Kurigram district, Bangladesh. American-Eurasian J. of Sustainable Agriculture, 2012; 6(2): 85-96.