A pharmacognostic, phytochemical and pharmacological review of *Terminalia bellerica*

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**Abstract**

*Terminalia bellerica* (*T. bellerica*) is a tree belonging to the family Combretaceae. In Ayurvedic system of medicine, it is used as “health – harmonizer” in combination with *Terminalia chebula* and *Emblica officinalis*. 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 like anti-diabetic, anti-microbial, anti-salmonella, anti-biofilm, anticancer, hepatoprotective, anti-pyretic and anti-diarrheal. 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*, Ayurveda system of medicine, phytoconstituents, pharmacological activity

**Introduction**

Nature serves as primary source for the cure of ailments [1]. It is estimated that, in many developing countries, two third of the population is dependent on medicinal plants to meet primary healthcare needs [2]. The use of herbal medicine is increasing due to its safety, efficacy and therapeutic potential as compared to synthetic pharmaceutical products [3]. However, the potential of higher plants as a source of herbal medicine is unexplored [1]. 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 known as bibhitaki belongs to the family Combretaceae. It is called vibheetaki in Sanskrit which means “fearless”, the fruit that takes away the fear of disease. In Indian history, it is said that, *T. bellerica* is inhabited by demons and those who sat under its shade were vulnerable to an attack by the same. Due to its medicinal properties tree has Sanskrit synonym of Anila-ghnaka, or “wind-killing”. The generic name ‘Terminalia’ is derived from Latin word, ‘terminus’ or ‘terminalis’ (ending), which means habit of the leaves being crowded or borne on the tips of shoots. It is a compound of *rasayana* preparation, made up of three myrobalan fruits, known as Triphala, which is important in Indian as well as Tibetan traditional medicines[4].

**Scientific classification** [4]

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Plantae</th>
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<tbody>
<tr>
<td>Division</td>
<td>Magnoliophyta</td>
</tr>
<tr>
<td>Class</td>
<td>Magnoliopsida</td>
</tr>
<tr>
<td>Order</td>
<td>Myrtales</td>
</tr>
<tr>
<td>Family</td>
<td>Combretaceae</td>
</tr>
<tr>
<td>Genus</td>
<td>Terminalia</td>
</tr>
<tr>
<td>Species</td>
<td><em>Terminalia bellerica</em></td>
</tr>
</tbody>
</table>

**Synonyms** [5]

Bahera, Baheda, Bibhitaki, Belleric Myrobalan, Bedda Nut Tree, Beach- Almond, Aksha, Karshaphala, Kalidruma, Bhutavasa, Kaliyugalaya.
Vernacular names [5]

Distribution and habitat [6]
It grows wild at an elevation of up to 2000m in a 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 [7].

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 [7].

Biophysical limits [7]
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 [8]
It is a large deciduous tree with the height of 50m and diameter of 30m with a rounded crown. It is branchless up to 20m. It is perennial and requires cold climate.

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

Leaves: Young leaves are copper red in colour which turn into parrot green and later they become dark green. Leaves are large, alternate, glabrous, with the dimension of 4-24cm x 2-11cm, mostly clustered at the twig ends. Leaf tip is narrowly pointed. Base of the leaf is rounded to cuneate, rufous-serious which turn to glabrescent, having 6-9 pairs of secondary veins. Secondary and tertiary venation are prominent on both the surfaces generally clustered towards the ends of branchlets. Petiole is 2.5-9cm long, flat above, with pair of sessile glands just above the middle, sometimes indistinct. Lamina is broad elliptical or broad obovate with the dimension of 8-20 x 4-14 cm. Apex is rounded to abruptly short acuminate. Margin is entire.

Flowers: They are greenish white in colour usually appear along with new leaves having an offensive odour or strong honey like smell. Flowers are simple, solitary and sessile. Inflorescence is axillary spikes generally 3-15cm long. Upper flowers of the spike are male. Lower flowers are bisexual. Calyx tube is sericeous or tomentulose.

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: Whole plant of *T. bellerica*  
Fig 2: Leaves of *T. bellerica*  
Fig 3: Flowers of *T. bellerica*  
Fig 4: Fruits of *T. bellerica*
Microscopy [3]
The various microscopical details that can be observed are hairs, stone cells, fibres, starch grains, xylem and calcium oxalate crystals. The details of which are as follows:

<table>
<thead>
<tr>
<th>Colour</th>
<th>Yellowish brown</th>
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| Hairs          | Length - 168 μm - 91 μm
                | Breadth - 14 - 7 μm                                                              |
| Stone cells    | Single stone cells                                                               |
                | Length - 378-42 μm                                                               |
                | Breadth - 70-28 μm                                                              |
                | Group of stone cells                                                             |
                | Length – 462 μm-112 μm                                                          |
                | Breadth - 308-70 μm                                                             |
| Fibres         | Length - 630 μm - 105 μm                                                         |
                | Breadth - 1.16 μm                                                               |
| Starch grains  | Simple starch grains                                                             |
                | Spherical with diameter ranging from 35 μm-14 μm                                |
                | Oval with the length of 31.5 - 28 μm and breadth of 28 – 21 μm.                  |
                | Compound starch grains                                                           |
                | Diameter - 85.9 μm to 112 μm                                                     |
| Xylem          | Spiral vessels with an average diameter of 17.5 μm to 70 μm                      |
                | Pitted vessels with an average diameter of 27.13 μm to 92.16 μm                  |
                | Pitted trachieds                                                                 |
| Calcium oxalate crystals | Needle shape crystals                                      |
Photochemistry

The different phytoconstituents which have been isolated and reported so far have been represented below.

<table>
<thead>
<tr>
<th>Table 2: Phytochemicals present in <em>T. bellerica</em></th>
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<tbody>
<tr>
<td><strong>Compounds</strong></td>
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<tr>
<td>Flavone</td>
</tr>
<tr>
<td>Steroids</td>
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<tr>
<td>Lignans</td>
</tr>
<tr>
<td>Tannins</td>
</tr>
<tr>
<td>Glycosides</td>
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<tr>
<td>Terpenoid</td>
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<tr>
<td>Saponin</td>
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<tr>
<td>Cardenolide</td>
</tr>
<tr>
<td>Flavonol aglycones</td>
</tr>
<tr>
<td>Flavonol glycosides</td>
</tr>
<tr>
<td>Fatty acids present in oil</td>
</tr>
<tr>
<td>Glycerides of fatty acids</td>
</tr>
</tbody>
</table>

Ayurvedic properties [8]

- **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
- **Kasanashanam** – relieves cough, cold
- **Netrahitam** – good for eyes
- **Keshya** – improves hair quality and promotes hair growth
- **Kruminashana** – relieves worm infestation
- **Vaisvaryanashana** – relieves hoarseness of voice
- **It detoxifies blood, lymph, muscle and fatty tissue of the body**
- **The seed kernel of vibhitaki is useful in**
Pharmacological activity

- Trut – excessive thirst
- Chardi – vomiting

The various reasons reported for the presence of the above mentioned phytoconstituents and their pharmacological activities are as follows:

- **Antispasmodic and bronchodilatory activity:** *In-vivo* and *in-vitro* studies were conducted to determine the mechanism of action for the medicinal use of *T. bellerica* fruit in hyperactive gastrointestinal and respiratory disorders. It showed combination of anticholinergic and Ca++ antagonist effects. In rabbit jejunum, it causes relaxation of spontaneous contractions. It inhibited carbachol and K+ induced contraction as well as it showed right shift in Ca++ concentration response curves. 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. In rodents, it showed protective effect against castor-oil induced diarrhoea and carbocar-mediated bronchoconstriction. In guinea pig trachea, it exhibited relaxation of contractions induced by CCh, right shift in CCh curves and inhibition of K+ contractions. Both chloroform, ethyl acetate and aqueous fraction exhibited anticholinergic effect whereas only aqueous fraction showed calcium channel blocking effect.

- **Anti-fungal activity:** 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, ethanol extract of *T. bellerica* fruit exhibited antifungal activity with the potential to inhibit drug resistant fungal strains.

- **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 *T. bellerica*. Alcoholic and water extract of *T. bellerica* showed significant anti-salmonella activity. Results suggested that aqueous extract exhibited bactericidal activity at higher concentration and bacteriostatic activity at low concentration. *T. bellerica* extract did not show any *in-vitro* cellular toxicity. Mice on pre-treatment with aqueous extract of *T. bellerica* showed 100% survival when challenged with lethal doses of *S. typhimurium*.

- **Anti-microbial activity:** A study was conducted to demonstrate the antimicrobial activity of methanol extract of *T. bellerica* against respiratory pathogens i.e., *Staphylococcus aureus* and *Klebsiella pneumonia*. Preliminary anti-microbial analysis showed that it inhibits coagulase activity of *S. aureus* whereas it causes biochemical alteration in both the strains. In *Klebsiella pneumonia* it causes major alternation in the capsular morphology after 24hr and 48hr of treatment respectively. The results indicate that *T. bellerica* possess antimicrobial activity against respiratory pathogens and hence can be used for treatment of diseases caused by pathogens.

- **Anti-oxidant activity:** 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 i.e., DPPH, β-carotene bleaching inhibition and reducing power whereas for chelating ability on Fe+2 ion, crude acetone extract showed higher activity. It was concluded that polyphenolic rich fractions were more effective than the crude extract.

- **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* mutants causing inhibition of biofilm formation. Hence, the study indicated that *T. bellerica* can be used as antibiofilm agent.

- **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.

- **Anti-Alzheimer’s activity:** 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 acetylcholinesterase inhibitory properties. All extract showed inhibition of enzyme activity in a dose dependent manner. Phytoconstituents like gallic acid, ellagic acid and phenolic acids present in fruit of all three plants inhibited acetylcholinesterase. Being, acetylcholinesterase inhibitor, it could be used for symptomatic treatment of Alzheimer’s diseases.

- **Antihypertensive activity:** A study was carried out to determine the mechanism of blood-pressure lowering effect of crude extract of *Terminalia bellerica*. In rats under anaesthesia, it induced a dose dependent fall in arterial BP where as in isolated guinea pig atria; it inhibited the force and rate of arterial contraction. In rabbit thoracic aorta, it causes relaxation of phenylephrine and K+ induced contractions as well as suppression of PE peaks in Ca2+ free medium. The vasodilator effect was endothelium-independent and it

### Table 3: Medicinal properties of *T. bellerica*

<table>
<thead>
<tr>
<th>Part of plant</th>
<th>Activities reported</th>
</tr>
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<tbody>
<tr>
<td>Whole plant</td>
<td>Antibiofilm [16], Anticancer [17], Anti-inflammatory [18], Antimutagenic [19], β-lactamase inhibitor [20]</td>
</tr>
<tr>
<td>Fruit</td>
<td>Analgesic [21], Antidepressant [22], Antidiabetic [23], Anti diarrhoeal [24], Antifertility [25], Antioxidative [26], Antiviral [27], Anti-HIV-1 [28], Antioxidant [29], Antipyretic [30], Anti-spasmodic and bronchodilatory [31], Antithrombotic and thrombolytic [32], Anti-secretory [33], Anti-spasmodic and bronchodilatory [34], Antithrombotic and thrombolytic [35], Antifertility [36], Hepatoprotective [37], Wound healing [38], Anti-Alzheimer’s [39], Anti-atherogenic [40], Anti-plasmodial [41], Cough, spleen, gastrointestinal disorders, clear bowels, flatulence, dysentery [42]</td>
</tr>
<tr>
<td>Bark</td>
<td>Immunomodulatory [43]</td>
</tr>
</tbody>
</table>
Anti-atherogenic activity: Anti-atherogenic effect of *Terminalia bellerica* was studied by investigating the effect of hot water extract of *Terminalia bellerica* fruit on low-density lipoprotein oxidation and inflammation on macrophages. It showed DPPH radical scavenging activity and 15-lipoxygenase inhibitory activity along with significant inhibition of free radical induced LDL oxidation as compared to solvent control. On treatment with *Terminalia bellerica* extract showed significant decrease in m-RNA expression of tumour necrosis factor-alpha (TNF-α), interleukin-1 (IL-1α), and intracellular reactive oxygen species (ROS) production in THP-1 macrophages. The results indicate that *Terminalia 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 [40].

Immunomodulatory effect: Methanolic extract of *Terminalia bellerica* fruit showed stimulation of morphage phagocytosis through the production of superoxide and acid phosphatase. It also showed activation in lymphocyte proliferation assay with phytohemagglutinin, concanavalin A, lipopolysaccharide and pokeweed nitrogen. However, at lower concentrations, it showed suppressant activity with concanavalin A and pokeweed nitrogen. The results indicated that T-lymphocyte proliferation effect of extract occurred through the same mechanism exhibited by phytohemagglutinin, concanavalin A whereas B-lymphocyte proliferation effect occurred through T-cell independent and T-cell dependent mechanisms, similar as lipopolysaccharide and pokeweed mitogen. 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 [42].

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 [38].

Antifertility activity: Benzene and ethanol extracts of *Terminalia bellerica* bark were administered orally for 50days to adult male rats. Biochemical estimation was done after dissecting and weighing epididymis and vas deferens. A decrease in the weight of accessary reproductive ducts was observed after treatment with *Terminalia bellerica* extract. It also showed an increase in total cholesterol content whereas a significant decreased in epididymal sperm count was observed. The results indicated the non-availability of androgens in rats treated with *Terminalia bellerica* bark [25].

Anti-diarrhoeal activity: An investigation was carried out to determine the anti-diarrhoeal effect of aqueous and ethanolic extract of *Terminalia bellerica* fruit in castor oil induced diarrhoea, PGE2 induced enter pooling and gastrointestinal motility test. The percentage protection in castor oil induced diarrhoea was found to be 73.37 and 63.58 by aqueous and ethanol extract respectively. Both the extracts showed significant anti-enter pooling effect in PGE2 induced enter pooling as in gastrointestinal motility test, percentage protection of aqueous and ethanolic extract was found to be 67.20 and 68.27 respectively. The results indicate that extracts exhibit prominent anti-secretory effect as compared to reduction in gastrointestinal motility. Presence of tannins, flavonoids and alkaloid could be responsible for anti-diarrhoeal effect, either by stimulating the reabsorption or anti-secretory effect in the intestinal lumen as well as significantly enhancing intestinal transit time and intestinal motility decreased [34].

Anti-cancer activity: 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 i.e., methanol, aqueous methanol, ethyl acetate, chloroform and pet ether. A moderate correlation was observed between the total phenolic content of all the extracts whereas the anti-oxidant activity and the total phenol content increased with increase in polarity. Pet ether extract showed most potent anti-cancer activities followed by chloroform against all cell lines namely ovarian carcinoma, liver carcinoma, breast carcinoma, HeLa contaminant, cervical carcinoma, breast carcinoma, cervical carcinoma, CNS-human glioblastoma, non-small lung cancer, colon adenocarcinoma, fibrosarcoma, leukemia and melanoma. Other extracts showed potent anticancer activity against leukemia and melanoma. According to results, petroleum ether extract exhibited the highest anti-cancer activity which would be used for further purification to isolate compound(s) responsible for the activities [17].

Anti-plasmodial activity: Antiplasmodial activity and cytotoxicity of water extract of *Phyllanthus emblica* Linn, *Terminalia bellerica* Retz and *Terminalia bellerica* (Gaertn) Roxb was evaluated by in-vitro and in-vivo studies. In-vitro anti-plasmodial studies were done by assessing the ability of all plant extracts to inhibit the uptake of [3H] hypoxanthine-resistant strain and in-vivo anti-plasmodial activity was evaluated by the standard 4-day suppressive test in *Plasmodium berghei* infected mice. Cytotoxic studies were carried out on Vero cell line. All plant extracts showed antimarial activity. *Terminalia bellerica* showed highest in-vitro antiplasmodial activity followed by *Phyllanthis emblica* Linn and *Terminalia chebula* Retz. All plants showed cytotoxic activity with the selectivity index ranging from 11 to 17. At 250mg/kg/day, all plant extracts showed in-vivo antiplasmodial activity with good suppression activity in standard 4-day suppressive test on *P. berghei* infected mice [41].

Anti-diabetic activity: 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. Isolated and synthetic gallic acid was administered to streptozotocin (STZ) – induced diabetic male wistar rats at different doses for 28 days. A significant dose-dependent reduction in plasma glucose level was observed. Gallic acid treated rats showed regeneration of β-islets cells as compared to untreated diabetic rats in histopathological examination. Oral administration of gallic acid showed decreased serum total cholesterol, triglyceride, LDL-cholesterol, urea, uric acid, creatinine along with marked increase in plasma
insulin, C-peptide and glucose tolerance level. It also restored total protein, albumin and body weight of diabetic rats. Hence gallic acid isolated from *Terminalia bellerica* could be used as anti-diabetic agent [23].

- **Hepatoprotective activity**: 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. It also showed reduction in nuclear factor-kappa B (NF-kB), cyclooxygenase-2 (COX-2) and tumour necrosis factor alpha (TNF-α) overexpression in injured livers, indicating amelioration of inflammatory response. There was significant suppression of hepatic fibrosis which was confirmed by transforming growth factor-beta 1 (TGF-β1) and alpha smooth muscle actin (α-SMA) expression. Hence, results indicate that *T. bellerica* possess hepatoprotective activity [27].

- **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 using *Phesentia posthuma* as test worms. Various bioassay methods were used, such as determination of time of paralysis and time of death of the worms. The results indicate that both the extracts showed significant paralysis and also caused death of worms at higher concentration as compared to Levimasole, reference standard. Hence, it was confirmed that *Terminalia bellerica* fruit possess anti-helminthic activity and further studies can be carried out to isolate active principle(s) responsible for this activity [27].

- **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. Ethanol extract and aqueous extract showed significant reduction in dose dependent manner in the mobility time of mice in FST as well as TST whereas there was no significant effect was observed on locomotor activity of mice. Activities of both the extract were found to be similar as imipramine and fluoxetine. Both the extracts showed reversed reserpine-induced extension of immobility period of mice in FST and TST. The aqueous and ethanolic extract induced antidepressant like effect in TST was significantly altered by prazosin, sulpride and p-chlorophenylalanine. Hence, both the extracts exhibited significant anti-depressant-like effect in mice by interaction with adrenergic, dopaminergic and serotonergic systems [22].

- **Analgiesic and antipyretic activity**: A study was done to investigate the analgesic and antipyretic activities of ethanolic and aqueous extract of *Terminalia bellerica* fruits in acetic acid induced writhing. Eddy’s hot plate method and brener’s yeast induced fever models in mice and rats. It was 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 [21].

- **Acute and subacute toxicities**: Acute and subacute toxicities of ethanol extract of *T. bellerica* were studied and it was found, a single oral dose of ethanol extract did not produce signs of toxicity, behavioural changes, mortality and differences on gross appearance of internal organs. In sub acute toxicity, all rats were administered with a repeated oral dose of ethanol extract for 14 days whereas the satellite group also administered with ethanol extract for same period but kept for further 14 days to check the delayed effects or reversibility of toxic effects. The results indicated that the ethanol extract did not show any change in general behaviours, mortality, weight gain, haematological or clinical blood chemistry parameters as well as gross and histological examination showed normal appearance of the internal organs as compared to control group [40].

- **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* determine the clastogenic potential. Various clastogenic abnormalities were observed such as reduction in mitotic index, inhibition of cell division, stickiness of chromosomes, chromatin bridge, fragments of chromosomes and lagging chromosomes. The mother tincture of *Terminalia bellerica* acts as stathomokinetic 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 [45].

**Contraindications** [46]

- It should be avoided during pregnancy as it is unsafe during pregnancy and breast feeding.
- It has blood sugar lowering activity, hence, diabetes medications needs to be adjusted for diabetic patient.
- Due to its blood sugar lowering activity, it may interfere with blood sugar control surgery, hence it should not be taken at least 2 weeks before surgery.

**Conclusion**

*Terminalia bellerica* has been extensively used as traditional medicine. It is a large deciduous tree, mostly native to Sri Lanka. Pharmacognostic evaluation of fruit powder showed presence of hairs, single and group of stone cells, fibres, simple and compound starch grains, spiral and pitted vessels, pitted tracheids and needle shaped calcium oxalate crystals. Phytochemical studies revealed the presence of various phytoconstituents such as tannins, flavonoids, steroids, lignin, glycosides, terpenoid, saponins, cardenolides, flavanol glycosides and fatty acids. It possess various pharmacological activities such as antispasmodic and bronchodilatory, anti-fungal, anti-salmonella, anti-microbial, anti-oxidant, anti-biofilm, anti-ulcer, anti-Alzheimer’s, antihypertensive, anti-atherogenic, immunomodulatory effect, wound healing, antifertility, anti-diarrhoeal, anti-cancer, anti-plasmodal, anti-diabetic, hepatoprotective, anthelmintic, anti-depressant, analgesic and antipyretic activity. It does not possess any acute and subacute toxicities. It is contraindicated during pregnancy and diabetic patients. This review has provided a complete insight into the pharmacognostic, phytochemical and pharmacological activity of *Terminalia bellerica*. 
However, there is a need for further study on phytochemistry and mechanism of action of pure compounds to fully understand the phytochemical profile and pharmacological effect of this plant.

References
37. Rashed K, Potočnik J, Giaconetti J, Škoda M,


46. www.m.webmd.com/vitamins/ai/ingredientmono-811/terminalia