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Review Article

A review on ethnobotany, phytochemistry and pharmacology on *Terminalia belerica* (Bibhitaki)

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Abstract

Terminalia belerica Roxb. is belonging to family combretaceae, which is growing widely throughout the Indian subcontinent, Bangladesh, Nepal, Sri-Lanka, and South East Asia. It is used in several traditional medicines to cure various diseases. There are different phytoconstituents Glucoside, Tannins, ellagic acid, ethylgallate, gallylglucose, chebulanic acid which are responsible for its wide therapeutic actions. It is mainly used as antioxidant, antimicrobial, antidiarrhoeal, anticancer, antidiabetic, antihypertensive and hepatoprotective agent. This review article sites the information of different pharmacological activities of *Terminalia belerica* which may be source for further research studies.

Keywords: Phytoconstituents, pharmacologicalactivities, *Terminalia belerica*, therapeutic actions.

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INTRODUCTION

Herbal medicines are used as a health care tool in various countries. All the developing countries are fully dependant on herbal remedies¹. *Bibhitaki*, also known as *Baheda* in Hindi², is one among three fruits of *Triphala*. *Triphala* is one of the Ayurvedic formulaions which may have antifungal, antibacterial, laxative, hypolipidimic, antidiabetic and immunomodulatory activities³. *Triphala* or its constituents used against infectious microorganisms also⁴. *Bibhitaki* means the fruit that takes away the fear of disease. Its botanical name is *Terminalia belerica* belongs to family *Combretaceae*⁵. A plant with active medicinal properties or constituents are used to treat disease in the traditional systems like Ayurveda, Siddha and Unani^{6,7}. Herbal medicines are prepared from different plant materials such as leaves, stems, roots, bark etc. They mainly contain biologically active ingredients and are used primarily for treating mild or chronic ailments⁸. Ayurvedic remedy is commonly used in India. Maximum the Ayurvedic formulations are good in cold, cough, dysentery and increases appetite. *Baheda* fruit may contain chemicals such as tannins, ellagic acid, beta cetosterol⁹. A ripened plant of *Baheda* used as a purgative. All medicinal plants are used to cure all disease which may affect the Human being¹⁰.

According to Ayurvedic principles this fruit (*T. belerica*) may increase the dryness of the tissue which may leads to ingest¹¹. *Bibhitaki* primarily supports formation of three body tissue i.e. nutrients plasma (*rasadhatu*),

muscle (*mamsadhatu*), bone (*asthidhatu*). It is a powerful medicine for a variety of lung conditions, in which bronchitis and asthma are involved. Plants produce a wide array of bioactive principles and contains a rich source of medicines. It grows all over India¹². In India, 45,000 plant species have been identified and out of around 15 to 20 thousands plants are found which may have good medicinal value^{13,14}.

SYNONYMS

1. Assam: *Bhomora, Bhomra, Bhaira*
2. Eng: *Beleric, Myrobalan*
3. Gujrat: *Bahedam, Beheda*
4. Hindi: *Bahera*
5. Kan: *Shanti, Shantikayi, Tare,*
6. Mal: *Tanni, Tannikai*
7. Mar: *Beheda*
8. Ori: *Beheda, Bhara*
9. Sanskrit: *Vibhita, Aksa, Aksaka, Bibhitaki*
10. Tam: *Thanakkai, Tanri, Tanirakkai*
11. Tel: *Tannikkaya, Vibhitakamai, Tan*¹⁵

BOTANICAL DESCRIPTION

Terminalia belerica Roxb. (Combretaceae) is mostly found in deciduous forests in India except a dry area¹⁶. In India the tree is mainly found in forests of Assam, Gujrat, Odisha, Andhra Pradesh, kerala, Tamil Nadu. *Baheda* is a large deciduous tree with broadly leaves cluster at the ends of the branches, a thick brownish grey bark, attaining a height 20 to 30 meters

in elevation¹⁷. The leaves are crowded around the ends of branches. Leaves are petiolate and around 8-20 cm long. The flowers are pale greenish yellow. Flowers arise from spikes of the leaf axils. Stamens are 3-5 mm long. The fruits are ovoid grey drupes with 1.5-2.5 cm in diameter¹⁸. It is widely distributed throughout the world especially in Indian subcontinent. Srilanka, Pakistan, Nepal and South East Asia¹⁹. This fruit is also known as *Beleric Myrobalan* in English, *Bhibhtaki* in Sanskrit, and locally it is known as *Bahera* in India. Various phytochemicals has been isolated from different parts of the plant in which alkaloid, coumarin, flavones, saponin, tannins, glycosides, terpenoid etc. are included²⁰.

Biology-flowers matured in the month of october-november and fruits in november-december. The tree shed leaves in November with young ones appearing with flowers²¹.

BIOPHYSICAL LIMITS

Altitude-0-2000m

Mean annual rainfall-900-3000mm

Mean annual temperature-22-28degree C

Soil type- fertile soil and good drainage.

PLANT DESCRIPTION

Family Name: Combretaceae

Kingdom: Plantae

Division: Magnoliophyta

Class: Magnoliopsida

Order: Myrtales

Family: Combretaceae

Genus: Terminalia

Species: belerica¹⁸

Figure 1: Whole Plant (Bibhitaki)

PHYTOCONSTITUENTS

Many of researchers have investigated *T. belerica* for its many biologically active phytochemicals. Some of phytochemicals are shown in Table 1.

S. No.	SOURCE	PHYTOCHEMICALS	Ref
1.	Plant Body	Tannins, gallic,ethyl and ellegic acid, galloylglucose, flavones, fructos, rhamnose, coloring matter, resins pheyllembin etc.	22,23,24
2.	Seed	Cardenolide, cannogenol3-O-D, phospholipids 14. Etc	25,26
3.	Fruit	Tainternilignan, thannilignan, flavones, anolignan B 5, gallic acid, beta setosterol and tannins. Alkaloids, saponin, polysaccharides, Steroid, belleric acid, galactose, chebulagic acid. Phenols, carbohydrates, and proteins etc.	27,28, 29,30
4.	Stem bark	Arjunogenin and its glycosides, belleric acid and bellericosides. Hydrolysable tannins, gallicacid, in the water soluble extracts.	25,31
5.	Leaf	Proteins, steroids and terpenoids. Three hydrolysable tannins, gallic acid, ellagic acid and methyl gallate ,eutolin, quercitin 3-O-a-L-rhamnosepyranoside. Saponins, tannins, amino acids, alkaloids, carbohydrates, 4-hydroxy-benzoic acid. Pyidine-30carboxamide, 4-dimethylamino-N,2,4-difluorophenyl beta-setosterol, etc.	32,33,34

<p>1. <u>GALLIC ACID</u></p>	<p>2. <u>ELLAGICACID</u></p>	<p>3. <u>GALLOYLGLUCOSE</u></p>
<p>4. <u>FLAVANONE</u></p>	<p>5. <u>RHAMNOSE</u></p>	<p>6. <u>FRUCTOSE</u></p>
<p>7. <u>EPOXY RESIN</u></p>	<p>8. <u>ETHYLGALLATE</u></p>	<p>9. <u>TANNIN</u></p>
<p>10. <u>CARDENOLIDE</u></p>	<p>11. <u>PHOSPHOLIPIDS</u></p>	<p>12. <u>THANNILIGNAN</u></p>
<p>13. <u>BETA SITOSTEROL</u></p>	<p>14. <u>ALKALOIDS</u></p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p> R^1 R^2 R^3 Corydine Me Me Me Corybulbine H Me Me Cavidine Me -CH₂- </p> </div> <div style="text-align: center;"> <p> R^1 R^2 R^3 Dehydrocorydine Me Me Me Dehydrocorybulbine H Me Me Dehydrocavidine Me -CH₂- </p> </div> </div>	

<div>15 <u>SAPONIN</u></div> <div> </div>		
<div>16 <u>BELLERIC ACID</u></div> <div> </div>	<div>17 <u>PHENOL</u></div> <div> </div>	
<div>18 <u>CARBOHYDRATE</u></div> <div> </div>	<div>19 <u>ANOLIGNAN B</u></div> <div> </div>	<div>20 <u>GALACTOSE</u></div> <div> </div>
<div>21 <u>STERIOD</u></div> <div> </div>	<div>22 <u>PHENOLS</u></div> <div> </div>	<div>23 <u>METHYLGALLATE</u></div> <div> </div>
<div>24 <u>LUTEOLIN</u></div> <div> </div>	<div>25 <u>QUERCETIN</u></div> <div> </div>	<div>26 <u>PYRIDINE</u></div> <div> </div>
<div>27 <u>4-HYDROXYBENZOIC ACID</u></div> <div> </div>	<div>28 <u>ARJUNOGENIN</u></div> <div> </div>	

AYURVEDIC PROPERTIES

Bhedanam: Eases motion, has laxative action. This is why *Triphala* is used as mild laxative.

Kasanashanam: relieves cough, cold

Netrahitam: good for eyes

Keshya: improves hair quality and promotes hair growth

Kruminashanana: relieves worm infestation

Vaisvaryanashan: relieves hoarseness of voice

Chardi: Vomitting²⁰

TRADITIONAL USES

In Ayurveda, the drug *T. belerica* is identified as an expectorant. It is an integral part of Ayurvedic laxative³⁵, astringent, anthelmic, and antipyretic which is useful in hepatitis, bronchitis, piles, coughs, eye disease such as myopia, corneal opacity etc. hoarseness of voice, it is also used as hair tonics³⁶. It has lithotriptic, rejuvenative and antibacterial properties. The fruits are used in astringents, digestive, aperients, stypic, narcotic, Unripe fruit is a mild laxative and ripe fruit is an astringent³⁷. Decoction of the fruit is used for cough. Flowers are greenish-yellow, borne in axillary, and having offensive odor. Stem are straight, frequently buttressed when large²⁴. The bark is mildly diuretic acid and also useful in anaemia and leucoderma. The palm may contain seed oil which is used in rheumatism. Maximum the triterpenoids present in the fruits possess antimicrobial activity. *T. belerica* also promotes hair growth³⁸. The fruit is chewable and curable for cough, cold etc. *Baheda* as also useful for diabetes, urinary disorder. The oil of Kernel may use in mice as purgatives³⁹. *Vibhitaki* is used primarily to lower *kapha*- related diseases and respiratory disorders. It can expel stones or other types may assemble in digestive, urinary, and respiratory tracts⁴⁰. One third of classic formulations *Triphala*, known as cleanser and nourisher of *kalphadosha*. Useful for maintenance of balancing the body including the body fluids. It is also used in treating disorders relating to the *manipura chakra* relating to functions of abdominal nervous system⁴¹.

Recent research shows that *bibhitaki* reduces levels of lipids; fatty acids through the body and specifically lower the lipid levels in the liver and heart. This shows a strong action in preventing heart, liver and fat congestion⁴². As a daily rejuvenating and preventive supplement *bibhitaki* is good, especially for *kapha* body types⁴³.

Digestion: It is known as the best tonics for the digestive systems, *Bibhitaki* juice keeps the system clean and resolves the digestive functions. **Respiratory System:** Problems related to respiratory such as asthma, bronchitis and phlegm can be prevented by *Bibhitaki*⁴⁴. **Cuts and Wounds:** Applying *Bibhitaki* paste on cuts and wounds can be prevented excessive bleeding. **For Dry and inflamed eyes:** Mainly the physician recommends ghee processed with *Bibhitaki*, *amla* and *haritaki* in treatment of dry and inflamed eyes⁴⁵. **For cough, cold, and bad throat:** The small bits of pulp of dry *bibhitaki* fruit has to be fried in pure *ghee*. These bits are chewed slowly to get relief in cold, cough and bad throat. **Diabetes:** *Bibhitaki* can be effectively used in diabetes. Then it normalizes *kapha* and *medhas*, which are main cause of diabetes⁴⁶. **Irritable bowel syndrome:** The dry fruit powder of this fruit help to reduce increased motility of Intestines in IBS. It also helps to reduce the inflammation of walls of intestine⁴⁷.

Precaution: This herb should not be used in excess and pregnant women have to avoid consuming *Bibhitaki*^{48,49}.

PHARMACOLOGICAL ACTIVITIES

Immunomodulatory Activity

A chemical agent that modifies the immune response or the functioning of the immune system is referred as immunomodulator. This is commonly known that macrophages give role in different mechanism against the infection of host and used in destroying the tumor cells. *T. belerica* fruit extract possess immunomodulatory activity which is proved by phagocytic and lymphocyte proliferation activity of fruit methanolic extract on the mouse. Where methanolic extract has been reported to stimulate the production of superoxide anions and acid phosphatase then it may promote the macrophage phagocytosis. *T. belerica* extract with concanavalin A and pokeweed mitogen caused suppressant activity. Whereas acetone extracts of *T. belerica* has been shown to increase the B- and T-cells proliferation along with increased IL-10 secretion whereas it reduced the production of IFN- α and IL-2⁵⁰.

β -Lactamase inhibitor Activity

The β lactamase inhibitor activity of 68 extracts from Indian herbs and spices was surveyed. Most promising results of the β lactamase inhibitor activity *in vivo* and *in vitro* were achieved from the herbal extracts of *Bibhitaki*. *Ginger* (*Zingiber officinales*), *Brahmi* (*Bacopamonnieri*), *Garlic* (*Allium sativum*), *Gurmar* (*Gymnemasylvestre*), *Satavar* (*Asparagus racemosus*), peels and seeds against *Staphylococcus aureus* as the test organism⁵¹.

Antibiofilm Activity

The ethanolic extract of a plant *Baheda* was tested for its antimicrobial activity against the oral plaque forming bacteria i.e. *Streptococcus mutans*. Used in a inhibition of formation of biofilm. Mostly investigates that the plant extract may showed activity against *Streptococcus mutans*. The extract also prevents in the formation of biofilm with the help of bacteria. The study explains the benefits of this herbal preparation which inhibits the biofilm formation by *streptococci*, oral pathogens⁵².

Antiulcer Activity

The antiulcer activity of ethanolic extract of *Baheda* fruits an ETB was searched out in pylorus ligation and ethanol also may help to produce ulcer models in rats. In both models the common parameter determined was ulcer index. ETB at doses of 250, 500 mg/kg orally produced significant inhibition of the gastric lesions induced by Pylorus ligation induced ulcer & Ethanol induced gastric ulcer. The extract (250 mg/kg & 500 mg/kg) showed significant reduction in free acidity and ulcer index as compared to control⁵³.

In Vitro Glucosylase Activity

T. belerica fruit rind powder was assessed for its antimicrobial activity by using Chloroform-Ethyl Acetate fractions. Maximum zone of inhibition was observed in both fractions. The fractionized compound Epigallocatechin gallate showed significant antimicrobial activity against *E. coli*, *B. subtilis* and *S. Aureus*⁵⁴.

Wound healing activity

Wound healing is a complex phenomenon which includes a number of processes such as migration and proliferation of both epithelial and connective tissues, formation of extracellular matrix proteins, alteration of connective tissue, parenchymal components, collagen synthesis. The wound healing potential of extract has been reported in rabbit model.

Extract paste (500mg/animal) was applied to skin incision from the dorsal area of rabbit. Significant increase in the levels of hydroxyproline, DNA and uronic acid contents and improvement on maturation, wound contraction and epithelialization was observed between 4-12 days. The study suggested that the herbal paste from *T. chebula* and *T. belerica* enhanced fibroblast function, improved production of glycosaminoglycan and deposition of collagen which is required for wound healing and may be useful in wound healing process⁵⁵.

Analgesic Activity

T. belerica extracts also have antisecretory and analgesic activities. The extract have dose range of 300-1000mg/kg inhibited the castor oil-induced intestinal fluid secretion in mice. The extracts also dose dependently (50-100mg/kg) where it may reduce the numbers of acetic acid in mice. These are the results which indicate that TB exhibit antisecretory and antnociceptive effects, hence justifying its medicinal use in diarrhea and pain⁵⁶.

Antidiarrhoeal Activity

By using castor oil the Anti diarrhoeal activity was performed to induced diarrhoea. Mainly PGE2 induced entero pooling and gastrointestinal motility test. Aqueous and ethalonic extract of fruit pulp of TB at the doses of 334mg/kg, 200 mg/kg were used. By this in the comparison of percentage initiate on these models showed that the extracts have anti secretory effect. An activity of reproductive system in rats. It was determined that Adult male rats were administered with 10mg/100g body weight of benzene and ethanol extracts of Terminalia belerica barks orally for 50 days. Repeated administration of TB bark extract results that it decreased weight of the reproductive ducts in male rats⁴⁸.

Antidiabetic Activity

Hexane, Ethylacetate and Methalonic extracts of TB fruits at the different doses of 200,300 and 400mg/kg,p.o for 60 days to Streptozotocin induced diabetic rats by increasing the plasma insulin, C-peptide and glucose tolerance levels, serum total protein, body weight. By adding of plant extracts it may decrease the serum levels of total cholesterol, triglycerides, urea, uric acid and creatinine in diabetic rats⁵⁷.

The reduction of glucose level and Oxidant enzymes such as Superoxide dismutase, glutathione reductase and acatalase were observed in blood and liver. Oxidative stress arise from an imbalance in the formation and metabolisms of reactive oxygen species (ROS). Antioxidants are the molecules that inhibit or reduce free radical reactions and finally prevent cellular damage. Both forms of antioxidants (enzymatic and non-enzymatic) are present in the intracellular and extracellular environments⁵⁹.

Antipyretic Activity

The antipyretic activity of ethanolic and aqueous extract of *Baheda* fruits (200 mg/kg) was studied in brewer's yeast-induced fever models in mice and rats. Both of extracts showed that inhibition of elevated body temperature when compared to corresponding control⁵⁸.

Acute and Sub-Acute Toxicities

The acute and sub-acute studies were conducted as per the guidelines of OECD. Single oral administration of the ethanolic extracts of *T. belerica* at a dose of 5,000 mg/kg did not produce any toxicity. In sub-acute toxicity, repeated administration of 1,000 mg/kg of *T. belerica* in 14 days which may not cause change in various effects of behaviours, mortality test, gaining

weight, blood chemistry initiatives. The results of examinations showed normal appearance of the internal organs when compared to those of the control group⁴⁹.

Antispasmodic and Bronchodilatory Activity

T. belerica fruit extract may promote the relaxation of spontaneous contractions in isolated rabbit jejunum and guinea pig ileum. In guinea pig trachea, TB relaxed the carbachol induced contractions. In which protective effect of TB against castor oil induced diarrhea². It also reserves the CCH and K⁺ - induced contractions in a pattern which is similar to that of dicyclomine. Carbachol may induce mediated bronchoconstriction also observed in rodents⁶⁰.

In Vitro Cellular Toxicity

In present study, ether, chloroform, acetone, alcoholic extract, and of *Baheda* fruit used for screening. When compared with other extracts both alcoholic and aqueous extracts of TB showed anti-salmonella activity. There was no cytotoxicity was observed in invitro cellular toxicity study⁶⁰.

In Vitro Immune Response

In vitro Phagocytic activity and lymphocyte proliferation assay were carried out methanolic extract of on the mouse immune system. In evaluations, incentive of macrophage phagocytosis and activation of phytohemagglutinin were observed. Finally, the authors concluded that the methanolic extract of *T. belerica* affected on the mouse immune system, specifically cellular and humoral immune response *in vitro*⁵.

Anti-salmonella Activity

T. belerica showed effects against *Salmonella typhii* and *Salmonella typhimariam*. *Invitro* cellular toxicity also performed by them. In this study different chemicals are used for the screening such as ether, chloroform, acetone, alcohol, of the plant. When compared with other extracts alcoholic and aqueous extracts of plant showed anti salmonella activity. And no toxicity was observed in *invitro* cellular toxicity study⁶⁰.

Antihypertensive Activity

The effect of *T. belerica* in hypertension. After administration of *T. belerica*, they observed that fall in the arterial BP of rats under anaesthesia. In isolated guinea pig atria, inhibition of force and rate of atrial contractions noted. In thoracic aorta of rabbit, relief observed after the administration of contractions which was produced by giving phenylephrine⁵⁶.

Hepatoprotective Activity

The protective effects of TB fruit extract and its active constituents against CCl₄ in toxicity. Treatment with extract (50,100 and 200mg/kg, p.o.) showed dose dependent recovery in parameters such as SGOT, SGPT and lipid peroxidase, glutathione but the effect of Galli acid is more reliable⁶¹. The liver is a vital organ of vertebrates and some other animals.⁶². Hepatotoxicity refers to inability of liver to detoxify the toxic compounds. In this one of the most sensitive and dramatic indicators of hepatocyte injury is the release of intracellular enzymes, such as transaminases and serum alkaline phosphatase in the circulation during hepatic abnormalities. Pharmacological activities of the enzymes are useful of cellular drainage and loss of morality of cell membrane in liver⁶³. Methanolic extract of *T. belerica* fruit has both reducing power as well as iron chelating activity and by tjis it may reduce the toxic level of iron in iron overload mice and hence protects liver from oxidative stress and fibrosis. Its administration lowered serum enzyme and serum ferritin levels, which act as a indicators of severe iron overload⁶⁴.

Antimicrobial Activity

T. belerica has shown potent action against infectious agents in vitro. Fruit extracts contains phenol, tannins, alkaloid, and flavanoids. Alkaloids are mainly responsible for inhibiting the microorganisms by impairing the enzymes involved in energy productions, interfering with the integrity of cell membrane and structural component synthesis. In the fruit extract of *T. belerica* have tannins may be useful in preventing the formation of microorganisms. *T. belerica* extracts inhibit the activity of this enzyme when *S. aureus* grown in the presence of *T. belerica* extract. The aqueous fruit extract has shown activity against numerous pathogenic bacteria viz. *Escherichia coli*, *Pseudomonas aeruginosa*, etc. *T. belerica* also showed antibacterial activity against many Gram positive and Gram negative bacteria including *Corynebacterium rubrum*, *Staphylococcus epidermidis*, *K. pneumoniae* etc. However, studies have demonstrated that antibacterial activity was associated with the polar extracts⁶⁵.

Anti-mutagenic Activity

Water, acetone, and alcoholic extracts of *Terminalia belerica* were found for their antimutagenic activity by using the various assay on of them is to be Ames Salmonella assay. Acetone extract exhibited variable inhibitory activity of 65.6 % and 69.7% with 4-O-nitrophenylenediamine and sodium azide, and 81.4% with 2-aminofluorene, in the preincubation mode of experimentation. Inhibition with chloroform and water extracts was rather insignificant⁶⁶.

Anti-urolithiatic Activity

Antiurolithiatic activity of fruits of the *Terminalia belerica* on ethylene glycol induced renal calculi in albino rats. In which renal stone was induced in rats around 0.75% ethylene glycol by drinking water for 25 days. After that a test dose are given with alcoholic extract of plant at different doses forms i.e. 100, 200, 400mg/kg b.w. once a day. Till 15-28th day. Where cystosone (750mg/kg) used as standard drug. The effect of plant on various parameters in urine also in serum was evaluated. The results demonstrated that Met B (400mg/kg) reduced the ethylene glycol induced disturbance in different parameters in urine or serum⁶⁷.

Nephrotoxic Effects

The rats were divided into 5 groups where 1st groups served as a control and injected with normal saline, 2nd group injected with Gentamicin or Silymarin 100mg/kg p.o., 4th or 5th group were injected with *Terminalia belerica* ethanolic or aqueous extracts plus gentamicin for 15 days. 2nd group showed early kidney dysfunction as serum urea, uric acid and creatinine which may increase. It indicates that GM induced nephrotoxicity. Administration of *T. belerica* plus gentamicin may protect kidney tissue against nephrotoxic effects⁶⁸.

Angiogenesis Activity

The angiogenic potential of *T. belerica* by in vivo mice sponge implantation assay. Here are gelatin sponge with or without ethanolic extract of *T. belerica* leaf were subcutaneously injected into albino mice and after 14 days the implanted sponges were excised and that section evaluate the presence of sponge. In which EETB may produce various blood vessels in gels which can sponges individually. Another vessels were filled in with red blood corpuscles which may shows the formation of a fibro vascular inside the sponges and blood may circulate in another formed of vessels by angiogenesis produced by EETB. Thus ethanolic extract of the plant leaf inhibit the profound angiogenic activity in vivo⁶⁹.

Antithrombotic and Thrombolytic Activity

A myocardial and cerebral infarction is serious consequences of the thrombus formed in blood vessels. A thrombus formed in circulatory system with the failure of haemostasis. Thrombolytic agents are used to remove the previous blood clots from blood vessels⁷⁰. used an in vitro model to check the antithrombotic effect of alcoholic and aqueous extract of *T. belerica* fruits. Streptokinase is used as a positive control. The study showed that extract delayed the clot formation⁷¹.

Mastitis Activity

Mastitis is most affecting disease of dairy industries. This study was to evaluate the antibacterial effects of hot aqueous extraction (HAE) of the fruits of *Terminalia belerica* on field isolates of mastitis. HAE of the fruits of *T. belerica* make mixture with another selected plants and used for their synergistic/antagonistic effect. The antibacterial potential was determined by disc diffusion method. The inhibition zone decreases after 24hrs which may show effect as bacteriostatic rather than bacteriocidal. After all this is justified that the use of *Triphala* as a compound of *Bahera* treat the clinical/subclinical mastitis⁷².

Toxicity Study and Anti-inflammatory Activity

Terminalia belerica extract administered at different doses such as 2000-1000mg/kg in acute or subacute toxicities studies. Antiinflammatory activities of *T. belerica* extract evaluated in carrageenan induced paw edema model. For the activity, the animals were divided into 5 groups. They have different doses such as Group-1 control, Group-2 Indomethacin 3mg/kg, Group-3 TBE 100 mg/kg, Group-4 TBE 200mg/kg, Group- 5 TBE 400mg/kg. Then the results show that the mortality and signs are non observable in acute and repeated toxicity studies after administration of TBE dose of 2000mg/kg. Antiinflammatory activity showed in carrageenan induced paw edema model 1, 3 and 5 h. A inhibition of paw as compared to control group was observed at different doses 100, 200 and 400mg/kg at 1, 3 and 5h. and comparable efficacy has been shown of indomethacin at 200mg/kg⁷³.

Antibacterial Activity

The antimicrobial activity was evaluated by using agar well diffusion method against the Gram -ve or Gram +ve bacteria such as *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Bacillus aureus*, *Pseudomonas aeruginosa*, *Salmonella*, *Escherichia coli* and *Azotobacter* etc. These bacteria are isolates using methanol, ethanol, acetone, chloroform and leaf extract of *T. belerica*. All by this it was observed that the ethanolic extracts gives the good activity against the tested bacterial isolates, as comparatively methanol, chloroform, or aqueous extract also. Hence, this study states that the *Triphala* and its constituents may reveal antibacterial activity against the human pathogenic bacteria⁷⁴.

Antioxidant Activity

Due to imbalancing in generation and metabolism of ROS an oxidative stress has been arise, when the more ROS produced than that is metabolized⁷⁵. The supplements used as antioxidants are help to reduce oxidative agents⁷⁶. The present study evaluated the antioxidant activity of *T. belerica* fruits. The study was to evaluate the antioxidant study, total phenolics, flavanoids content of aqueous (AETB) and ethanolic extract (EETB) of fruits of *T. belerica*⁷⁷. The antioxidant activity was investigated by DPPH (1,1-diphenyl-1,2-picrylhydrazyl), ABTS (2,2-Azino-bis 3-ethyl benothiazoline-6 sulphonic acid diammonium salt, superoxide, nitric oxide, reducing power and TAC (Total antioxidant capacity)⁷⁸. The higher antioxidant

activity has been shown by AETB as compare to EETB in nitric oxide, superoxide etc. In antioxidant activity the reducing power increases in dose dependent manner which may show higher absorbance at 700nm for AETB that is 0.95+-0.03 as compare to EETB which is 0.43+-0.01. The total phenolic and flavanoids amount were also determined. The antioxidant activity of *T. belerica* fruit were contributes by TPC and TFC⁷⁵.

Anticancer Activity

In Ayurveda the main constituent of *T. belerica* is Triphala which may have the cytotoxic effects against different cancer cells, breast cancer cell, pancreatic cancer cell, prostate cancer cell. The acetone extract of *T. belerica* exhibited antimutagenic potency using microsome assay. These extracts are having different inhibitory activity 65.6% and 69.7% with 4-O-nitrophenylenediamine and sodium azide also⁶⁶.

Anti-obesity Activity

The study investigated the effect of ethanolic extract of fruits of *Terminalia belerica* on Atherogenic diet which may induced obesity in rats. The rats were divided into 4 groups i.e. group1-control rat, group2- obesity control, group3- obesity +500mg/kg fruit body weight of extract of *T. belerica*, group4-obesity+10mg/kg body weight of sibutramine. Body temperature, weight gain, feed and water intake, BMI and lipid profile were measured. The continuous administration of ethanolic extract of *T. belerica* at the dose of 500mg/kg had significant effect in the parameters similar to drug of Sibutramine. The ethanolic extract of *Terminalia belerica* is useful in the treatment of obesity⁷⁹.

CONCLUSION

The extensive survey of literature revealed that *Terminalia belerica*, it is an important medicinal plant with various pharmacological spectrum. Further study of ayurvedic human uses of herbs, is found as an useful for the locate advanced medicaments. In which one of the plant of *Terminalia belerica* is widely used in Ayurveda. Crude extracts of various parts of *Terminalia belerica* plant have been found to contain constituents such as Glucoside, Gallo-tannic acid, colouring matter, resins, ellagic acid, gallic acid, lignans, termilignan, ethyl gallate, phenyllembilin Tannins, mannitol, fructose, rhamnose. These compounds are responsible for the pharmacological activities i.e. antimicrobial, antioxidant, antisalmonella, hepatoprotective, antispasmodic, and anticancer activities. Further the plant is used in the treatment of gastric ulcer, constipation, piles. Hence, this plant provides a significant role in the prevention and treatment of disease. Further evaluation needs to be carried out in order to explore the concealed areas and their practical clinical applications, which can use for the welfare of the mankind.

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