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THE PHARMACOLOGICAL PROPERTIES OF SEVERAL SPECIES OF *TERMINALIA* IN THE WORLD

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ABSTRACT: Traditional medicines, derived from medicinal plants, are used by about 60% of the world's population. Plants of the genus *Terminalia* which consist of about 200-250 species are widely used as traditional medicine. The aim of this study was that review morphologic and toxonomic characteristics, pharmacological effects, traditional usage and products that derived of *Terminalia* in reports that published up to 2017. To conduct this review, the most up-to-date electronic journals including those indexed in the Pubmed, Elsevier, Institute for Scientific Information, Google Scholar and Scientific Information Database, databases and various books, has been used. *Terminalia species* have therapeutic effects such as cardiac stimulant effect that was compared with that of digoxin. *Terminalia species* possess several active phytochemicals with antioxidant activities. *β*-sitosterol is one of phytosterol compounds that has a therapeutic effect on inflammation by effect on prostacyclin I2 (PGI2) and prostaglandin E2 (PGE2). Other active phytochemical are tannins that have shown that tannins have strong anti-bacterial properties. Considering that many studies have been carried out on *Terminalia* plants in different fields and its beneficial effects in various diseases. To identify phytochemical compounds, further studies are required to fully determine the extent of use of medicinal plants and the phytochemistry of the genus *Terminalia*. In this review article can be a preliminary authentic source for the researchers to investigate the some unknown potential and therapeutic effects of these medicinal plants.

INTRODUCTION: Medicinal plant is a momentous element of endemic medical systems all over the world. Ethnobotany is a rich resource for natural drug research and development. There are 80,000 species of medicinal plants on the earth [1, 2, 3]. Since ancient times, herbal plants have been used to treat a variety of ailments and diseases. Medicinal and aromatic plants are the basis of primary health care of the majority of population in developing countries like Asia which is also an important economic source.

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Indeed, over three-quarters of the world's population rely on plants and plant extracts as their primary health care which is the most affordable and easily accessible source of treatment. The literature has noted that therapeutic use of plants is as old as 4000 - 5000 B.C [4].

More than 30% of all plant species have been used for medicinal purposes. Traditional Chinese medicine (TCM) and African medicinal systems also heal wide variety of their diseases and ailments with herbal medicines [3]. It was the Chinese who first used natural herbal preparations as medicines. Likewise, in developed countries, people are attracted to the use of traditional and safe medicines. In developed countries such as the United States, it has been reported that 25% of synthetic drugs have herbal origins, while in developing countries like India and China, this

amount is 80%. Plants with active medicinal constituents are used to treat diseases in traditional systems like Ayurveda, Siddha and Unani. In Asia, the application of medicinal plants is well-established and well-documented in different medical literatures, for example the names of medicinal plants, their properties and usage are listed in "The Canon of medicine" by Avicenna, the century's great physician. Plants of the genus *Terminalia* are widely used as traditional medicine which contain about 200-250 species of medium to large flowering trees, many of which have a history of usage in traditional medicine [3, 5]. Among of them, 6 species have Asian (India) origin, 14 species are African, 2 species have American origin and 3 species are of Oceania (Australia) origin [4, 6].

The aim of the present review was to investigate various studies and information that published up to 2017, regarding species of *Terminalia arjuna*, *Terminalia bellerica*, *Terminalia citrina* and *Terminalia ferdinandiana* and to finally present an exhaustive classification of morphological, phytochemical, pharmacological and traditional uses of these popular species and a comparison of their attributes is also provided.

Taxonomy of Several Species of *Terminalia*: As it was mentioned, genus *Terminalia* contains more than 200 species. Among these, 6 species are Asian (India), 14 species are of African origin, 2 species are of American origin and 3 species are of Oceania (Australia) origin **Table 1** [5, 6].

TABLE 1: *TERMINALIA* GENUS IN SEGMENTATION OF AFRICA AND ASIA

American origin	Asian origin	African origin	Oceania (Australia) origin
T. australis	*T. arjuna*	*T. albida*	*T. complanata*
T. Triflora	*T .chebula*	*T. avicennioides*	*T. muelleri*
	T. nigrovenulosa	*T. brachystemma*	*T. ferdinandiana*
	T. bellirica	*T. brownii*	
	T. alata	*T. glaucescens*	
	T. pallida	*T. ivorensis,*	
	T. citrina	*T. laxiflora*	
		T. macroptera	
		T. mollis	
		T. phanerophlebia	
		T. sericea	
		T. spinosa	
		T. stuhlmannii	
		T. superba	

TABLE 2: TAXONOMY OF SEVERAL SPECIES OF *TERMINALIA*

Division	Class	Order	Family	Genus	Species
Magnoliophyta	Magnoliopsida	Myrtale	Combretaceae	*Terminalia*	*Arjuna* *Citrina* *Bellirica* Roxb. *Ferdinandiana* *Catappa* L. *Chebula* *Acuminate* *Australis* *Avicennioides* *Bentzoe* *Brownii* *Calamansanai* *Coriacea* *Elliptica* *Eriostachya* *Glaucescens* *Mauritana* *Macroptera* *Vorensis* *Mollis* *Muelleri* *Myriocarpa* *Sericea* *prunioides*

The taxonomy of several species of *Terminalia* is presented in **Table 2** [2, 7, 8].

Morphology of *T. arjuna, T. bellirica* and *T. ferdinandiana*: These available plant species are observed tall deciduous. The bark is mostly fissured and the branches are arranged in rows. The leaves are generally huge and coriaceous. Some taxonomists have split the genus into sections or sub genera according to the fruit characteristics. Fruits may be yellow, green, dark red or black drupes which are usually angled or winged, some of which are edible and in fact might be highly nutritious. More details are presented below [3, 5]:

***Terminalia arjuna*:** The tree is about 60-80 feet high, with drooping branches and an extensive crown. The leaves are simple, oblong or elliptic, pale dull green on top and pale brown on the bottom. Petioles are 6-10 mm long with one or two eminent glands at the top immediately below the leaf. This is a unique pharmacological characteristic of *T. arjuna* Roxb. The bark is thick, soft and smooth gray; red color from internal side, curved and rather flat part. Stems are often fluted and buttressed and devoid of shrubs scales. The flowers are white or yellowish. The fruits are drupe, 2.5 - 5cm long, oblong or ovoid, smooth-skinned with five hard angles or wings. Seeds are hard with germination of 50-76 days [50-60%]. They are bitter savour with a characteristic odor [2, 7, 9, 10].

***Terminalia bellirica* Roxb:** *Belliirica* is a large deciduous tree of 50 m height and a diameter of 3m with a rounded crown. The buttressed bole at the base is often branchless up to 20 m. The bark is bluish or grey, the inner bark is yellowish. It is covered with numerous longitudinal cracks. Leaves are large, smooth and glabrous, intermittent, broadly elliptic to obovate-elliptical, 4-24 cm × 2-11 cm, cuneate or rounded at base, rufous-sericeous but soon glabrescent, with 6-9 pairs of secondary veins. Secondary and tertiary venation prominent on both surfaces, clustered towards the ends of branchlets. Young leaves are copper-red which soon become parrot green, and later dark green. Flowers are single, small, 3-15 cm long, greenish white and simple. The flowers emerge along the new leaves and have a strong honey-like smell. Fruits are sub-spherical widely ellipsoid, 2-4 × 1.8-2.2 cm, density velvety or sericeous and light-yellow [5, 11, 13].

***Terminalia ferdinandiana*:** *T. ferdinandia* grows in sandy soil. Trees of this species are semi-deciduous and medium-sized. They are abundant in the wild and are relatively stable from attack by insects and other animals. Trees of ferdinandiana can bear fruit when they are 5 to 6 years old, in some areas, they bear fruit twice a year, December to February then around April. The fruits are 1.5 to 2 cm long with an ovoid shape, they are smooth fleshy drupes with a short beak at the tip. At first, the fruits are yellow, after being ripped, they become green. The fruits are being used as a food source by local people of the northern regions of Australia for centuries. They are styptic with a tart taste, they are a bit bitter when eaten fresh [14, 15, 16]. Some of the information about this and some other species is presented in **Table 3**.

TABLE 3: A SUMMARY OF COMMON NAMES AND HABITS OF SEVERAL SPECIES OF GENUS *TERMINALIA*

Scientific name	Common name	Habitat	Reference
T. citrina	Yellow myrobalan, Manahei	Forest of Gazipur, Tangail,	3
	Leathery Murdah	Sylhet, Chittagong, Rangamati	8
	Irani: Halilah-i-zard	and Chittagong hill tracts of	12
	Bengali: Haritaki	Bangladesh	17
	Monalu (Assam),		18
	Suravaari Harad (Gujarat)		
T. bellerica	English: Belleric Myrobalan, Bastard myrobalan	Indian subcontinent, Sri Lanka,	2
	Unani: Balelaa, Baheraa	South- East Asia, Bangladesh	3
	Siddha/Tamil: Thaanrikkaai, Thandri		5
	San: Aksha, Vibhita, Bibhitaki		8
	Hind: Bulla		11
	Bengali: Bahera		12
	Malayalam: Thanni		13
	Arabic: bellied		
	Iran: Balilah		

T. arjuna	English: *Arjun terminalia* Unani: Arjun Siddha: Marudam. San: Arjunah, Kakubhah Hin: Arjun, Kahu, Kahua Mal: Marutu, Nirmarutu, Venmarutu Attumarutu, Pulamatti Tam: Attumarutu, Nirmarutu, Marutu Kan: Maddi	Throughout the greater part of India, *e.g.*, Uttar Pradesh, Bihar and also in the Deccan region, mainly on the riversides, also grown as an avenue tree	2 3 5 6 7 8 19
T. ferdinandia	Is known as Kakadu plum, gubinge, bush plum, billy goat plum and salty plum	Endemic to Australia, mainly in the tropical grasslands of the Northern Territory and the Kimberley region of Western Australia	3 15 16

Traditional Uses: Nowadays herbal plants have an important role in retaining human health and longevity. Usage of medicinal plants exhibits a very significant aspect of the traditional medicine which is institutionalized in any culture of people of developing and developed countries [3]. Some species of *Terminalia* are extremely important, because of their multiple beneficial effects. They have different names, for example *T. bellerica*, as wind killing [20] and *T. chebula* as the king of the plants in Ayurveda and also, *T. arjuna* which is known as "white marudah" and as a sacred medicinal plant; it is one of the most important herbal medicines in India and is traditionally used as a cardioprotective remedy[4]. **Table 4** summarizes the traditional uses of some plants of *Terminalia* by some countries including India, Bangladesh, Iran, Australia, *etc*.

TABLE 4: PARTS USED IN TRADITIONAL MEDICINE OF SOME SPECIES OF *TERMINALIA*

Botanical name	Part used	Medicinal properties/ indications	Reference
T. arjuna	Bark	CVS and CNS stimulator, diuretic in cirrhosis of liver and strangury, abortifacient, cardio-protective and cardio-tonic in angina and poor coronary circulation and ischemic heart diseases. It is also used for diarrhea, dysentery, tubercular cough, asthma, earache, cleansing sores, ulcers and syphilitic infection, sex stimulation, skin disorder, herpes and leukoderma, relieving excessive menstrual bleeding and leucorrhoea. The bark extract contains acids, glycosides, strong antioxidants, minerals, *etc*. Potent chemo-preventive efficacy against N-nitrosodiethylamine-induced liver cancer. The powdered bark is prescribed with milk in fractures and contusions with excessive ecchymosis. Ayurveda Pharmacopoeia of India recommends the powder of the stem bark in emaciation, chest diseases, lipid imbalances and polyuria, hypercholesterolaemia, as well as in fungal and microbial infections, or as anti-fertility and antidote against poisons. A folk medicine in Bangladesh suggests to soak the bark of *T. arjuna* and drink the water once a day on an empty stomach for 4 days for treatment of dysentery, and 41 days for the problem of low sperm count. 50g powder obtained from dried leaves is taken with 20g sugar twice daily for heart disease and treatment of diabetes without using any modern diagnostic procedures by Kabirajes and local people to cure obesity, hypertension and hyperglycemia. The bark constituents are promising as anti-mutagenic and anti-carcinogenic remedy	2 3 4 7 8 19 20 21 22
	Leaves	Analgesic, anti-inflammatory effects	
	Fruit	Obstruent	
T. citrina	Fruit	Improvement of chronic fever and appetite, sexual stimulant, asthma, constipation, boils, migraine, dental disorders, dizziness, hemorrhoids, anemia, eye diseases, infections, wound cuts, cardiac disorders, hepatomegaly and urolithiasis, inflammation, pain, diarrhea and other digestive disorders and helmintic contaminations	2 3 8 17 18
	Seed	Stomachache and intestinal diseases such as colitis. Possess antioxidant properties	
	bark	Used as diuretic and cardio tonic	

T. bellerica	Fruit	Half ripped fruits are used as purgative, and ripped fruit as astringent, antipyretic, used in prescriptions for diarrhea, dyspepsia, biliousness cough, bronchitis and upper respiratory tract infections, tropical pulmonary eosinophilia and allergic eruptions, antiseptic, tonic, expectorant, laxative, treatment of leprosy and dropsy. The powder form is used for emesis and worm infestation, hepatoprotective, anthelmintic, useful in hepatitis, asthma, piles, hoarseness of voice, eye diseases and scorpion-sting, used as a hair tonic. The sodden green fruit is used for cough. The triterpenoids present in the fruits possess significant antimicrobial activity. It is also used as astringent and digestive, and it is also used for making a lotion for sore eyes. The flower has shown to have spermicidal activity	2 3 8 11 12 13
	Kernel	As anodyne, kernel oil has purgative action	
	Bark	Gum of the bark is painkiller and laxative	
T. ferdinandia	Fruit	Among other species possess the highest antioxidant activity, thus, useful in cardiovascular disorders and cancer	
	bark	The inner bark was used to treat several skin diseases and infections, including ulcer, boils, treating leprosy and useful in controlling fungal infections such as ringworm	3 15 16

Pharmacological Studies: Following the traditional uses of *T. arjuna*, *T. citrina*, *T. bellerica* and *T. ferdinandiana*, they have been scientifically studied for the potential of the plant in treatment of different ailments and disorders. Pharmacological activities of the species are as follows:

Cardiovascular Effects: The phytochemical test of *T. arjuna* stem and bark showed the presence of flavonoids, alkaloid, triterpenoids, saponins and tannins that triterpenoids, flavonoids, tannins and phytosteroid compounds have significant anti-oxidant hyperglycemic and cardio-protective activities. Besides, for *T. arjuna* increased prostaglandin E2 (PGE2) activity has been reported [7, 9]. As PGE2 produce coronary vasodilation, this increase may be responsible for the increased coronary flow following *T. arjuna* consumption [7].

A number of experimental and clinical studies have demonstrated that the bark powder of *T. arjuna* has potent hypolipidemic and cardio-protective activities. A study was carried out on the experimental evaluation of *Terminalia arjuna* on cardiovascular system in comparison with digoxin. To compare and evaluate the efficacy of aqueous extract of *T. arjuna* with digoxin, 4 parameters heart rate and amplitude of frog's heart in situ, heart rate and amplitude of hypodynamic frog's heart in situ, heart rate and amplitude of isolated perfused rabbit heart and coronary flow of the isolated perfused rabbit heart) were considered. In this study, aqueous extract of *T. arjuna* was pharmacologically assayed for its actions on cardiovascular system for its cardiac stimulant effect. These effects were examined on frogs and rabbits. The cardiac stimulant effect of *T. arjuna* was compared with that in digoxin. The preparations used were; frog's heart *in-situ*, hypodynamic frog's heart in situ and isolated perfused rabbit heart. Eight experiments of similar nature were carried out with graded doses of aqueous extract of *T. arjuna* and digoxin for each experiment. The results indicated that *T. arjuna* (Aq.E) increased the force of contraction of cardiac muscle in frog's heart in situ, hypodynamic frog's heart in situ and isolated perfused rabbit heart. *T. arjuna* (Aq.E) also caused dose- dependent bradycardia in isolated perfused rabbit heart. Nonetheless, cardiovascular evaluation of *T. arjuna* was less potent in comparison with digoxin, because high doses of digoxin were required in different experiments. The fundamental mechanism for the increased contraction force is unknown which might be due to various glycosides present in the bark of *T. arjuna*. Other reports in this regard, are as follows [7, 9, 23]:

- ✓ *T. arjuna* produced a positive inotropic effect.
- ✓ Ameliorative effect in patients with CHF.
- ✓ *T. arjuna* treatment in patients of refractory chronic congestive heart failure caused improvement of symptoms, signs and effort tolerance.

Needless to say that some species have important phytochemical compounds such as antioxidants, tannins, alkaloids, glycosides, which are useful in

the treatment of coronary artery disease, cancer, *etc*. It is due to the fact that antioxidant contents are associated with the reduction of degenerative disease [3, 11, 24, 25, 26].

Antioxidant and Free Radical Scavenging Activities: Previous studies proved that consuming high amounts of antioxidants could reduce the risk of chronic diseases and prevent the development of degenerative diseases such as cancer, cardio-vascular problems, neural degeneration, diabetes and obesity. A detailed study on the antioxidant activity of methanol and ethanol extract of all the parts *T. arjuna* and *T. bellerica* plants showed that the highest amount was found in methanolic extracts of *T. arjuna* stem bark (1.95 ± 0.01 mg/100 g). Since, flavonoids and phenolic compounds have a significant role in treating severe diseases, some studies have focused on the phenolic and flavonoids contents. In comparison with different parts like leaf, bark and fruits, high contents of phenol were observed in the stem parts which was more than the other parts. The methanolic extract also had higher content of flavonoids in stem bark of *T. arjuna* (0.90 ± 0.33 mg/100 g), moreover, the phenolic content was also high in methanolic extracts of *T. bellerica* leaves. DPPH free radical scavenging activity was studied by computation percentage inhibition of methanolic and ethanolic extracts in *Terminalia species*. Accordingly, the maximum percentage inhibition value was observed in methanolic extract of *T. arjuna* stem bark [3, 9, 12, 16, 27].

Seeds of *T. citrina* were reported to have anti-oxidant properties and also, five tannins including corilagin, punicalagin, 1, 3, 6-tri-O-galloyl-*β*-D-glucopyranose, chebulagic acid and 1, 2, 3, 4, 6-penta-O-galloyl-*β*-Dglucopyranose were identified which were isolated from methanol extract of the fruit. A comparison was performed between the different species of *Terminalia*, based on their antioxidant content. Of these Australian species, *T. ferdinandiana* has the highest level of antioxidant. Reports indicated that the fruits of this plant have the highest ascorbic acid levels, as high as 6% of the recorded wet weight, almost 900 times higher (g/g) than ascorbic acid value in blueberries (as a standard). Therefore, *T. ferdinandiana* fruit is used for the production of vitamin C in pharmaceutical, cosmetic and food industries.

The crude aqueous extract of *Terminalia belerica* fruits has antioxidant compounds including enzymatic and non- enzymatic antioxidants [13]. The induction of oxidative stress is associated with cancer and cardiovascular disorders. Thus, it is likely that the high antioxidant contents of many *Terminalia species* may inhibit cancer formation and/or progression [3, 7, 9, 12, 16, 25, 28, 29, 30].

Antimicrobial Activity: Methanol and aqueous extracts of *T. arjuna* bark were active against multidrug resistant *Escherichia coli* Dk1 and *Staphylococcus aurous* MRS901 tested by agar well diffusion method. Crude ethanol extract of *T. arjuna* bark was not active against a clinical multidrug resistant strain of *Escherichia coli*, *Klebsiella pneumoniae* and *Candida albicans* and against ATCC strains of *Streptococcus mutans*, *Staphylococcus aureus*, *Enterococcus faecalis*, *Streptococcus bevis*, *Pseudomonas aeruginosa*, *Salmonella typhimurium*, *Escherichia coli*, *Klebsiella pneumoniae* and *Candida albicans* [5]. A methanol extract of triphala (a mixture containing *T. chebula*, *T. arjuna* and *Emblica officinalis*) showed to be active against multi-drug resistant to *Salmonella typhi* strain. Previous studies on this part of the plant also showed antimicrobial activities (1,000-5,000 ppm) of dichloromethane and aqueous extracts against *Escherichia coli*; and of the crude drug against *Bacillus subtilis* and *Staphylococcus aureus* [3, 5].

Other *in-vitro* experiments have been conducted regarding the tannins of some species of *Terminalia* which revealed that the tannins present in the extract of this species has strong anti-bacterial properties. Some other relevant studies are as follows:

In study on tannins, the hydrolysable tannins had anti-herpes simplex virus effect (HSV) and in the primary stages of HSV infection, the extract of *T. arjuna* helps barricade viral attachment and intrusion. One of the hydrolysable tannins present in *T. arjuna* showed to possess antiviral activity of casuarinin *in-vitro*. Indeed, this compound prevented the adhesion and influence of the virus and also misadjusted the late event of infection. *In-vitro*, *T. arjuna* bark also barricade exudation of hepatitis B virus (HBV) surface antigen (HBsAg) [3, 5, 7, 9].

Other studies have also obtained interesting antimicrobial results with *T. bellerica*, as follows:

In one study, the antibacterial activity of *T. bellerica* fruits against 4 clinical strains of methicillin resistant *Staphylococcus aureus* (MRSA) and a strain of methicillin sensitive *S. aureus* (MSSA), isolated from diseased human eyes, were determined and these medicinal plants showed a broad-spectrum antibacterial activity against all MRSA and MSSA strains with an inhibition zone size of 17-27 mm and minimum inhibitory concentrations (MIC) between less than 1500 µg/mL to 8200 µg/mL. The vibriocidal activity against 12 isolates of *Vibrio cholerae* non-O1, and one reference strain of each *Vibrio cholerae* and *Vibrio parahaemolyticus* was also determined on *Terminalia bellirica* fruits aqueous, acetone, and ethanol extracts. Ethanol extracts showed MIC between 2500 and 20000 µg/mL. *T. bellirica* fruits ethanol extract also showed some activities against *Candida albicans* (MIC of 7000 µg/mL) [5, 7, 11, 12, 13]. A study has been done on the antibacterial properties of *T. ferdinandiana* fruit pulp extracts. According to this experiment, methanol extract was effectual at preventing the growth of *P. mirabilis, A. Faecalis, P. fluorescens, S. pyogenes* and *S. newport*, as seen by minimum inhibitory concentration. In fact, the growth of these bacteria was hindered by low concentrations (<100 µg/mL) of the extract [3, 16].

Anti-inflammatory Activity and Immuno-modulation: Inflammation is a response to injury. *Terminalia species* possess several active phytochemicals, many of which with antioxidant activities. It is likely that some of these activities are needed in different aspects of inflammatory process. *β*-sitosterol is phytosterol compounds existed in large amounts in species of *Terminalia*. *β*-sitosterol has a therapeutic effect on inflammation, affecting prostacyclin I2 (PGI2) and prostaglandin E2 (PGE2). *T. arjuna* leaf extracts have potent *in-vivo* anti-inflammatory activity. Relatively, the leaves of *T. arjuna* have analgesic and anti-inflammatory properties [3, 7, 9, 11, 13, 28, 30].

Digestive Disorders: Seeds of *T. citrina* are used in treating stomach aches and intestinal diseases such as colitis, diarrhea and hemorrhoid. *T. ferdinandiana* also possesses potent inhibitory activity on gastrointestinal protozoan parasite *Giardia duodenalis* and a number of bioactive components [3, 5]. *T. arjuna* was evaluated against *Helicobacter pylori* lipo-polysaccharide induced gastric damage in rats. The efficacy of *T. arjna* on gastric secretory parameters such as the volume of gastric juice, pH, free and total acidity, pepsin concentration and cytoprotective parameters such as protein-bound carbohydrate complexes in gastric juice and gastric mucosa were assessed. The protective impact of *T. arjuna* was confirmed by histopathological inspection of gastric mucosa. HP-LPS-induced alterations showed that gastric secretory parameters and gastric defense factors of rats treated with *T. arjuna* were desirable which confirmed the anti-secretory role of this plant [7, 9, 13]. In an experiment, the aqueous and ethanolic extracts of fruit pulp of *T. bellerica* were used to evaluate the effect of this species on digestive tract. It was found that the extracts had more anti-secretory effect than decreased gastrointestinal motility [13].

Other Therapeutic Properties: Some scientific literature have reported therapeutic properties of *T. arjuna* and *T. bellerica* including: anti-bacterial, anti-viral, anti-mutagenic, anti-spasmodic and bronchodilatory properties along with analgesic activity, antibiofilm activity, anticancer activity, wound healing activities, immunological activity, antihypertensive effect, antiulcer activity, anti-thrombotic and thrombolytic activities, hepato-protective activity, antimutagenic activity, anti-dysentric, anti-pyretic, anti-diabetic, gastric and reproductive activities [7, 9, 11, 13, 22, 26, 31].

Drugs with Herbal Formulation of Some Species of *Terminalia*: Medicinal plants have always been resources of traditional and even modern medicines, because they have compounds effective in treating diseases and ailments. Some reliable data on the application of medicinal plants and their important phytochemical compounds in modern drugs are as follows:

The World Health Organization has calculated that 80% of people worldwide use medicinal plants for their early health care, and 20% of the ingredients are herbal compounds. Nearly, 75% of the new anticancer drugs existed between 1981 and 2006 were obtained from plant compounds.

Genus *Terminalia* has also been applied widely for medicinal purposes, because of its numerous medicinal properties [3]. Several herbal medicines of *Terminalia species* are formulated in different countries, such as India, Bangladesh, Thailand, Iran, *etc*. Some of these are: Arjunarishta, Triphala, Hemolax, BR-16A (Mentat), PIL-28, OST-6 (Osteo Care) and Abana.

Arjunarishta: Arjunarishta is an Ayurvedic liquid medicine known as arthadyarishtam, partharishtam *etc*. Arjunarishta contains 6-12% alcohol. This herbal medicine is effective in the treatment of chest injuries, weakness, fatigueness, respiratory and intestine disorders; it is also used as herbal cardiac tonic [2, 32].

Arjunarishta Ingredients: The ingredients of Partharishtam are [31]:

- Arjuna tvak - *Terminalia arjuna* (Family: Combrataceae) - stem bark: 4.8 kg
- Mrudvika - *Vitis vinifera* (Family - Vitaceae) - dry grapes: 2.4 kg
- Madhuka - *Madhuca indica* (Family: Sapotaceae) - flowers: 960 g
- Dhataki - *Woodfordia fruticosa* (Family: Lythraceae) - flowers - 960 g
- Guda - Jaggery: 4.8 kg
- Water : 49.152 L

A coarse powder of *Arjuna* bark, grapes and *Madhuka* flowers were prepared and blended with 49.152 L of water. This mixture is boiled, stirred at regular times and brought to 12.288 L, cooled and filtered. Dhataki flowers and jaggery are added and then the mixture is fermented. After the fermentation, the extract is filtered and saved in sealed containers. This formulation is manufactured by important Ayurveda Pharmaceutical companies like, Zandu, Dabur, Baidyanath and Arya Vaidya Sala (Kottakkal) [2, 32].

Arjunarisht Dose: 12-24 ml once or twice a day usually advised after food. If needed, it can be mixed with equal quantity of water. The American Himalayan Foundation was founded in 1981 by a small group of climbers. Presently, this company produces important herbal medicines. This company has produced several herbal remedies, some of which include species of *Terminalia*. The products include: BR-16A (Mentat), OST-6 (Osteo care), Abana, Arjuna, PIL-28, Hemolax and Triphala [32].

BR-16A (Mentat): Mentat is a herbal formulation consisting of Brahmi (*Bacopa monnieri*), Mandookparni (*Centella asiatica*), Ashwagandha (*Withania somnifera*), Jatam ANSI (*Nardostachys jatamansi*), Shankhapuspi (*Evolvulus alsinoides*), Tagar (*Valeriana wallichi*), Vach (*Acorus calamus*), Guduchi (*Tinospora cordifolia*), Malkangni (*Celastrus paniculatus*), Kuth (*Saussurea lappa*), Amla (*Embelica officinalis*) and other ingredients of Triphala (*Terminalia chebula* and *Terminalia belerica*) [33].

PIL-28: Contains powders of *Balsamodendron mukul*, shilajeet (purified), *Melia azadirachta* and extracts of *Berberis aristata*, *Emblica officinalis*, *Terminalia chebula*, *Terminalia belerica*, *Cassia fistula*, *Bauhinia variegate* and *Mesua ferrea*. Clinical experiments have shown that PIL-28 significantly improves the patients' general health and reduces symptoms of hemorrhoids such as pain and bleeding [34].

PIL-28 Uses: This herbal medicine has astringent, antibacterial, antiseptic, anti-inflammatory and demulcent properties. It is very effective in reducing pain and inflammation in hemorrhoids, also it is used as laxative in treating constipation caused by hemorrhoids. This is useful for the elderly suffering from hemorrhoids, because severe strain during constipation may produce systemic complications [34].

OST-6 (Osteo Care): In Ayurveda some plants have been marked as being effective in the fracture and bone metabolic disorders. OST-6 (Osteo Care) is a herbomineral preparation formulated with plants effective in several bone disorders. The formulation of this herbal medicine includes: *Terminalia arjuna* W & A, *Withania somnifera* Dunal and *Commiphora mukul* Hook Ex stock and praval bhasma. *Terminalia arjuna* is widely used in the treatment of osteodystrophic conditions. *Withania somnifera* is known as a rejuvenating elixir in Ayurveda, which helps reduce pain in osteodystrophic conditions, it is also effective in relieving general weakness, nervous exhaustion and muscle pain. *Commiphora mukul* helps vail in mineralization of the bones.

Praval bhasma is a rich and natural source of calcium. Each gram of OST-6 contains *Terminalia arjuna* (bark 250 mg), *Withania somnifera* (root 250 mg), *Commiphora mukul* (gumresin 280 mg) and pravalbhasma (220 mg) [35, 36, 37].

Abana: Abana is another herbomineral drug which is effective in reducing serum cholesterol, triglycerides and other lipoproteins such as LDL and VLDL. It has several beneficial ingredients such as *Terminalia arjuna* (Arjun), *Withania somnifera* (Ashwagandha), *Tinospora cordifolia* (Giloe), *Phyllanthus emblica* (Amla), *Terminalia chebula* (Haritaki), *Asparagus racemosus* (Shatavari), *Nardostachys jatamansi* (Jatamansi), *etc*. It has exhibited effectiveness in protecting the heart and in reducing lipids. In this regard, a study was performed on the effects of abana on lipoproteins in patients suffered from high blood pressure and angina [38, 39, 40].

Triphala: Another popular polyherbal medicine is triphala (TPL). This herbal medicine was mentioned in Indian traditional medicine and in ancient Iranian medicine, Al-Qanoon Felteb literature. Triphala is also used for cardiovascular disorders, liver dysfunction, inflammation and obesity triphala is rich in Mg, K, Ca, Fe, Se and Zn. Also, it has gallic acid and polyphenols [41].

CONCLUSION: Plants have been used for the treatment of diseases throughout the world since the beginning of civilization. Ayurvedic medicinal plants (especially *T. arjuna*, *T. bellerica*, *T ferdinandiana* and *T. chebula*) have received great attention. These species have reported to have strong antioxidant, anticancer, antidiabetic, anti-septic, wound healing, cardiotonic and anti-inflammatory effects. Some other studies reported anti-dysentric, anti-pyretic, anti-diabetic, gastric and reproductive activities. They are also useful in anti-bacterial, anti-viral and anti-mutagenic remedies. The most exciting aspects of *T. arjuna* are in the treatment of diabetics, cancer and heart diseases. To identify phytochemical compounds, further studies are required to fully determine the extent of use of medicinal plants and the phytochemistry of the genus *Terminalia*. Therefore, this review can be a preliminary authentic source for the researchers to investigate the unknown potential of these medicinal plants.

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