



ISSN : 0973-7057

Standardization of fruits of *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn. and *Terminalia elliptica* Willd. with special reference to their pharmacognostic study

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Received : 11th April, 2025 ; Revised : 12th May, 2025

DOI:-<https://doi.org/10.5281/zenodo.18513990>

Abstract- The genus *Terminalia* (Family: Combretaceae) has a long-standing reputation in traditional medicine and is noted for its diverse range of secondary metabolites. In the present investigation, a comparative assessment was carried out on the fruits of *Terminalia arjuna* (Roxb. ex DC.) and *Terminalia elliptica* Willd., with emphasis on their physical, physicochemical, and phytochemical characteristics. Fresh fruit samples were observed for organoleptic and macroscopic traits, while parameters such as moisture content, extractive value, and total ash were quantified. Moisture analysis indicated a higher content in *T. elliptica* (38.26 ± 1.13), suggesting greater susceptibility to microbial contamination during storage. In contrast, *T. arjuna* exhibited a comparatively higher extractive value (3.33 ± 0.33), whereas the ash value was observed to be greater in *T. elliptica* (3.67 ± 0.33). Fluorescence tests along with preliminary phytochemical screening were also performed. The phytochemical study confirmed the presence of alkaloids, flavonoids, phenolic compounds, proteins, and tannins in both species. These findings provide useful baseline information that may aid future researchers in the authentication and standardization of *Terminalia* species.

Keywords: Standardization, Physical, Physicochemical, Phytochemical, *Terminalia*, Fruit

INTRODUCTION

Since ancient times, plants have served as primary therapeutic agents and were relied upon as the chief source of medicines before the advent of modern pharmaceutical practices. In India, the traditional system of Ayurveda continues to hold strong relevance, with nearly 85% of the population still depending on herbal formulations and crude plant-based remedies for managing diverse health conditions and disorders.¹ Although natural drugs offer several advantages, including affordability, accessibility, and relatively few adverse effects, they are often subjected to adulteration. Hence, proper authentication of the raw

material becomes a crucial step to guarantee consistent quality, which in turn plays a vital role in ensuring both the safety and therapeutic effectiveness of herbal formulations.²

Pharmacognosy is the branch of science that focuses on the study and identification of natural medicines, mainly those derived from plants. It involves examining the physical, chemical, and biological properties of these natural drugs to ensure their quality and authenticity. Essentially, pharmacognosy helps in understanding the sources and nature of plant-based medicines used for treating various health conditions. *Terminalia*, a genus belonging to the Combretaceae family, includes around 200 to 250 species of medium- to large-sized trees, many of which have long been valued in traditional medicine.³ The genus *Terminalia*

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is recognized for producing a wide variety of secondary metabolites.⁴

T. arjuna (Roxb. ex DC.), a key herb in Ayurvedic medicine, is valued for its therapeutic properties and is also referred to by names such as Arjuna, Indradru, Partha, and Veeravriksha.⁵ The leaves of *T. arjuna* are simple in structure, typically featuring crenulated edges. They are arranged in a subopposite manner and have tips that are either shortly pointed or rounded. The texture is leathery, and the shape ranges from oblong to elliptic. The upper surface of the leaves appears either pale or dark green, while the underside displays a light brown hue. This tree produces small, white, bisexual flowers that are sessile and form in short axillary spikes or occasionally in terminal panicles. Its fruits are drupe-like, ovoid in shape, and have a fibrous, woody texture with a smooth exterior. Notably, each fruit bears five distinct, hard, wing-like ridges that are obliquely positioned and curve upward. The stem bark presents a smooth, pinkish-gray appearance externally, while the inner bark is soft and has a reddish coloration.⁶ *T. arjuna* exhibits a wide range of therapeutic properties, including cholesterol-lowering, lipid-reducing, blood-thinning, blood pressure-regulating, anti-clotting, as well as antiviral, antifungal, and antibacterial effect.⁷

Terminalia elliptica Willd. is a species classified under the genus *Terminalia* and belongs to the family *Combretaceae*. It is also known by several botanical synonyms, including *T. alata*, *T. crenulata*, and *T. tomentosa*. In Hindi, the plant is commonly referred to as “Asana” or “Saj”.⁸ It is a tall tree, typically growing to a height of 20 to 35 meters, and is frequently found in forested regions.⁹ *T. elliptica* has a long history of use in traditional medicine, where different parts of the plant have been employed to address conditions such as diarrhoea, dysentery, ulcers, bleeding disorders, bone fractures, bronchitis, heart-related issues, and imbalances associated with *pitta* and *vata* doshas.^{10,11} Different parts of *T. elliptica* have been associated with a variety of pharmacological activities. The plant is known for its antidiarrhoeal¹², antileucorrhoeal¹², antimicrobial¹³, and antioxidant¹³ properties. Leaf extracts, in particular, have shown significant antifungal¹⁴, antiepileptic¹⁵, anti-secretory, anti-inflammatory, and antibacterial effects¹⁶. Additionally, extracts from the bark have demonstrated anti-inflammatory and anti-arthritic potential in various experimental studies.¹⁷

MATERIALS & METHODS

Collection and Preparation of extracts

T. arjuna fruit was collected from the field of Dr. Shyama Prasad Mukherjee University, Ranchi and *T. elliptica* fruit was collected from the field of Central Tasar Research And Training Institute (CTR&TI), Ranchi in the month of December. The harvested plant specimens were first rinsed thoroughly with tap water to eliminate any surface contaminants or dust. After cleaning, the samples were dried completely in a hot air oven maintained at 60°C. Once dried, the plant materials were ground into a fine powder using an electric grinder and then stored in airtight containers for further use.

To prepare different extracts from the powdered plant material, the cold maceration method was used. After extraction, the solutions were filtered and then evaporated at 30°C to obtain the dried crude extracts. These dried extracts were stored in tightly sealed containers until they were needed for further analysis.

Organoleptic and Macroscopic Study

Colour: The natural, unprocessed part of the sample was observed under sunlight to assess its color.

Odour and Taste: A small quantity of the sample was taken for sensory evaluation. The aroma was assessed by gently inhaling over the material several times, while taste was evaluated by placing a small portion on the tongue to identify its flavor profile.

Size and Shape: The length and width of the fruit were measured using a standard ruler. Its shape was determined by comparing it with descriptions available in established botanical references.

Surface Characteristics: The texture and other external features of the surface were examined and verified through comparison with documented characteristics found in relevant literature.

Physicochemical Analysis

A physicochemical evaluation of the crude powders derived from *T. arjuna* and *T. elliptica* fruits was conducted in accordance with the standards outlined by the World Health Organization.¹⁸ The study assessed various physicochemical parameters, including moisture content, total ash, water-insoluble ash, and extractive values in different solvents such as chloroform, acetone, ethanol, methanol, and water. Additionally, fluorescence characteristics were examined following established standard protocols.¹⁹

Phytochemical Analysis

Preliminary phytochemical screening was carried out on the crude fruit powders of *T. arjuna* and *T. elliptica*.²⁰ The extracts were analyzed for the presence of various bioactive compounds, including alkaloids, carbohydrates, cardiac glycosides, flavonoids, phenolic compounds, proteins, saponins, terpenoids, and tannins.

RESULTS & DISCUSSION

Organoleptic and Macroscopic characteristics

The organoleptic evaluation of the fruits from both *Terminalia* species revealed distinct colour, odour, and taste. Macroscopic examination covered features such as shape, size, and surface texture. A summary of these observations is provided in Table 1.

Physicochemical Study

The results of various physicochemical analyses of the powdered drug are presented in Table 2. A low moisture content in the samples suggests reduced likelihood of microbial contamination during storage. Ash content is a useful parameter for assessing the quality and cleanliness of a crude drug, as it can reveal the presence of inorganic substances like carbonates, oxalates, and silicates. Water-soluble ash specifically reflects the proportion of water-soluble inorganic matter. Extractive values help assess the range and nature of chemical constituents present in the crude drug, with each solvent targeting specific classes of compounds. Among the solvents used, ethanol yielded the highest extractive value for both *Terminalia* species, suggesting a significant presence of polar phytochemicals such as alkaloids, flavonoids, phenolic compounds, and proteins. Additionally, fluorescence analysis of the fruit powders treated with different chemical reagents revealed distinct fluorescence patterns under visible light, short-wave UV, and long-wave UV, as summarized in Table 3. However, various research papers showed different physicochemical values for the fruits of both species.²¹⁻²³ Such variations could be attributed to differences in environmental conditions, seasonal timing of sample collection, or the influence of different host plant species.

Qualitative phytochemical analysis of different extracts of fruits of *Terminalia* species

Preliminary phytochemical analysis offers insight into the chemical constituents of the drug. Alkaloids, flavonoids, phenols, proteins, and tannins were identified during the phytochemical investigation. Several studies have reported the presence of similar phytoconstituents in fruits of *T. arjuna* and *T. elliptica*.²³⁻²⁶

Table 1: Organoleptic and Macroscopic characteristics

Sl. No.	Parameters	<i>T. arjuna</i>	<i>T. elliptica</i>
1.	Odour	Odourless	Odourless
2.	Color	Dark brown when mature	Green when young
3.	Taste	Astringent	Astringent
4.	Shape	Fibrous woody	Oblong to elliptic-ovate
5.	Size	2.5-5 cm in size	5.5 cm length, 3.5 cm wide
6.	Surface Characteristics	Smooth, 5 hard projecting veined wings	Deeply fissured



T. arjuna Fruit



T. elliptica Fruit

Fig. 1 Freshly collected fruits of *T. arjuna* and *T. elliptica*

Table 2 : Physicochemical Parameters of Fruits of *T. arjuna* and *T. elliptica*

Parameters	<i>T. arjuna</i> fruit	<i>T. elliptica</i> fruit
Moisture content	34 ± 0.42	38.26 ± 1.13
Water soluble extractive	3.33 ± 0.33	2.67 ± 0.33
Methanol soluble extractive	3.33 ± 0.33	3.00 ± 0.33
Ethanol soluble extractive	4.67 ± 0.33	4.67 ± 0.33
Acetone soluble extractive	2.33 ± 0.33	2.33 ± 0.33
Chloroform soluble extractive	3.33 ± 1.86	1.67 ± 0.33
Total ash	2.67 ± 0.33	1.67 ± 0.33
Water insoluble ash	3.67 ± 0.33	1.33 ± 0.33

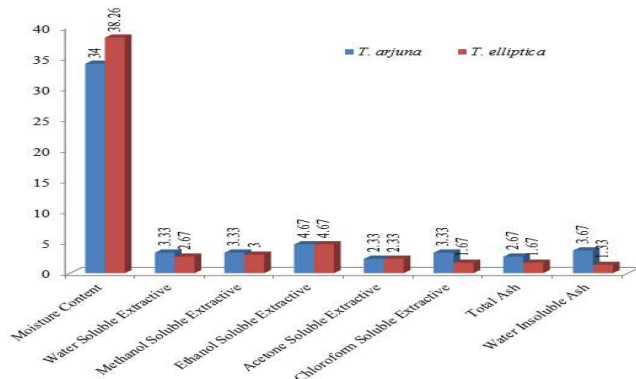


Fig. 2 Comparison of physicochemical parameters of fruits of *T. arjuna* and *T. elliptica*

Table 3 : Fluorescence Analysis of *T. arjuna* Fruit

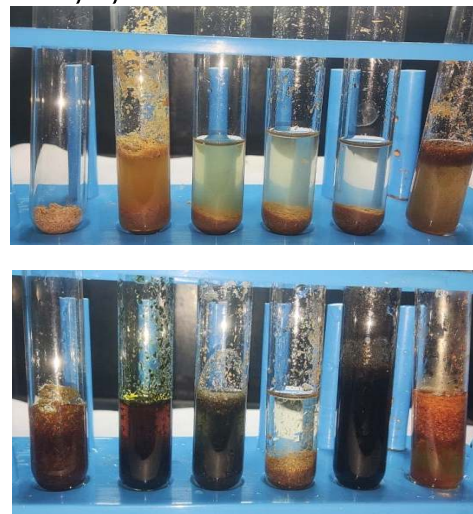
Treatment	Visible light	Short UV (254nm)	Long UV (365nm)
Powder	Dark brown	Light green	Dark green
Powder + Distilled water	Reddish brown	Dark green	Black
Powder + Methanol	Dark brown	Light green	Dark green
Powder + Ethanol	Reddish brown	Light green	Dark green
Powder + Petroleum ether	Dark green	Light green	Fluorescent red
Powder + Chloroform	Greenish brown	Greenish black	Black
Powder + 20% NaOH	Yellowish brown	Dark green	Greenish black
Powder + 5% FeCl ₃	Dark blue-black	Black	Black
Powder + Formic Acid	Brown	Greenish black	Black
Powder + Ethyl Acetate	Dark brown	Light green	Fluorescent red
Powder + 50% H ₂ SO ₄	Dark brown	Dark green	Black
Powder + 70% HNO ₃	Orange	Light green	Greenish black

Source:- Asian Paints Color Chart

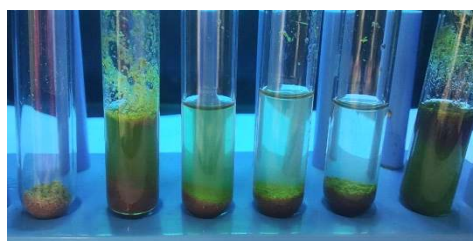
Table 4 : Fluorescence Analysis of *T. elliptica* Fruit

Treatment	Visible light	Short UV (254nm)	Long UV (365nm)
Powder	Brown	Green	Brown
Powder + Distilled water	Dark brown	Brownish green	Dark brown
Powder + Methanol	Yellowish brown	Light green	Light brown
Powder + Ethanol	Yellowish brown	Light green	Light brown
Powder + Petroleum ether	Yellowish brown	Light green	Light brown
Powder + Chloroform	Light brown	Dark green	Black
Powder + 20% NaOH	Dark brown	Greenish brown	Reddish black
Powder + 5% FeCl ₃	Dark brown	Greenish black	Black
Powder + Formic Acid	Black	Greenish black	Black
Powder + Ethyl Acetate	Light brown	Light green	Fluorescent red
Powder + 50% H ₂ SO ₄	Black	Black	Greenish black
Powder + 70% HNO ₃	Orangish brown	Fluorescent green	Fluorescent red

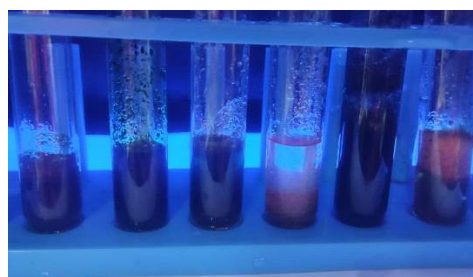
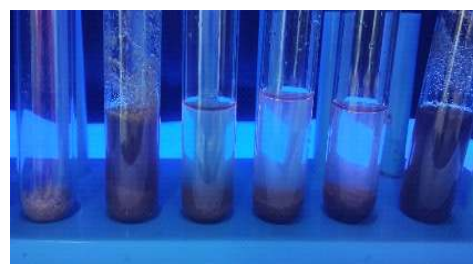
Source:- Asian Paints Color Chart



Visible light



Short UV (256 nm)



Long UV (365 nm)

Fig. 3 Fluorescence analysis of fruits of *T. arjuna*

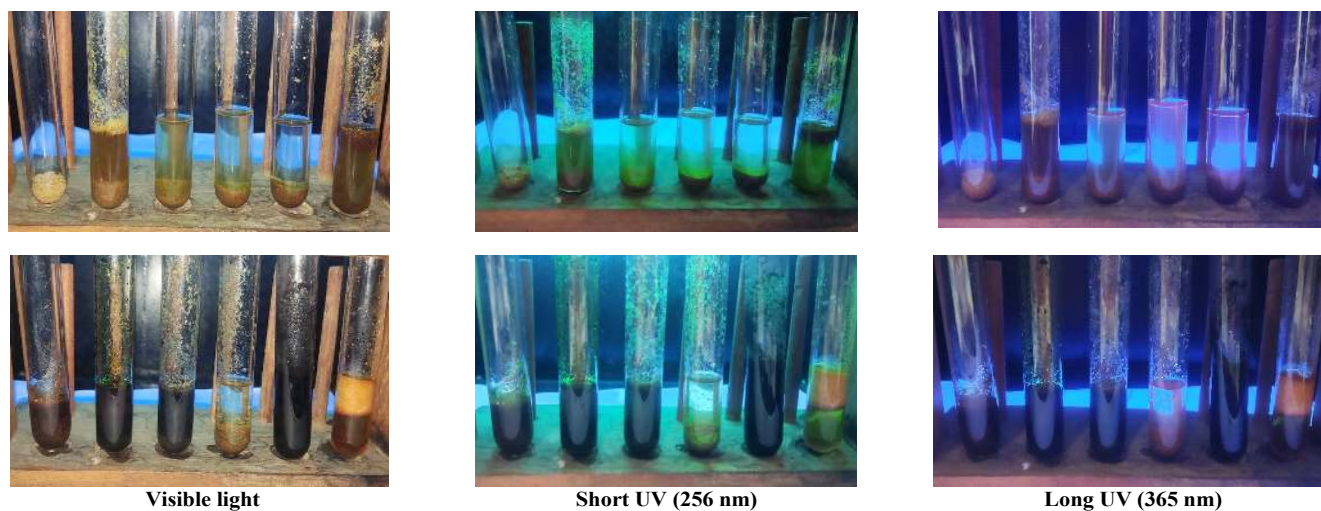


Fig. 4 Fluorescence analysis of fruits of *T. elliptica*

Table 5: Qualitative Phytochemical analysis of different extract of Fruits of *T. arjuna* and *T. elliptica*

Phytochemicals	Test	<i>T. arjuna</i>			<i>T. elliptica</i>		
		Aqueous	Methanol	Ethanol	Aqueous	Methanol	Ethanol
Alkaloids	Dragendroff's Test	+ve	+ve	+ve	+ve	+ve	+ve
Carbohydrates	Molisch's Test	+ve	+ve	+ve	-ve	-ve	-ve
Cardiac Glycosides	Keller Kelliani's Test	-ve	-ve	-ve	-ve	-ve	-ve
Flavonoids	Alkaline reagent Test	+ve	+ve	+ve	+ve	+ve	+ve
Phenols	Ferric chloride Test	-ve	-ve	-ve	+ve	+ve	+ve
Proteins	Millon's Test	+ve	+ve	+ve	+ve	+ve	+ve
Saponins	Foam Test	+ve	+ve	+ve	-ve	-ve	-ve
Tannins	Braymer's Test	+ve	+ve	+ve	+ve	+ve	+ve
Terpenoids	Salkowski's Test	+ve	+ve	+ve	+ve	+ve	+ve

CONCLUSION

The organoleptic properties and macroscopic features of *T. arjuna* and *T. elliptica* support their use in various traditional and modern medicinal systems. These observable characteristics support the identification and quality assessment of the plant materials. Additionally, the physicochemical parameters established for both species may serve as reliable benchmarks for standardization and quality control in herbal drug development. Furthermore, preliminary phytochemical screening of extracts prepared using three different solvents revealed the presence of diverse bioactive compounds. The detection of these phytoconstituents supports the therapeutic relevance of these plants and aligns with their widespread incorporation in Ayurvedic formulations.

ACKNOWLEDGEMENT

The authors express their sincere thanks to Dr. Shyama Prasad Mukherjee University, Ranchi, and the Central Tasar Research and Training Institute, Ranchi, for granting permission to collect plant samples. We are also

grateful to the University Department of Botany, Ranchi University, Ranchi, for providing the essential facilities and support required to complete this study.

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