



CHAPTER 4

Phytochemical & pharmacological profiling of *Ficus racemosa* bark: an integrated study of its ethnobotany and ecological importance

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Abstract: *Ficus racemosa* Linn. bark is a cornerstone of traditional knowledge and a key ecological component. This study integrates its ethnobotanical uses, phytochemical composition, pharmacological activities, and ecological significance. Traditionally, the bark treats diverse ailments like dysentery, diabetes, skin diseases, and inflammation. Phytochemically, it is rich in flavonoids, phenolic acids, steroids, saponins, and triterpenoids. Pharmacologically, it exhibits significant antidiabetic, anti-inflammatory, antioxidant, antimicrobial, and hepatoprotective effects. Ecologically, *F. racemosa* is a basis species, providing vital food for frugivores (e.g., birds, mammals, bats) and contributing to soil stability. This integrated analysis highlights its therapeutic potential and critical role in ecosystem health, advocating for its sustainable utilization.

Keywords: Ethnomedicinal, ecological, pharmacological, phytochemical



INTRODUCTION

Medicinal plants have long been the foundation of conventional healthcare systems because they are a rich source of bioactive compounds with therapeutic potential. This long-standing endorsement of nature-based healing highlights the significance of scientific validation of traditional methods and the exploration of novel phytomedicines. The genus *Ficus* is classified into six different subgenera: *Urostigma*, *Pharmacosycea*, *Ficus*, *Sycidium*, *Sycomorus*, and *Synoecea*. The *Ficus* originated from the tropics, extended into warm temperate zones and displays interspecific morphological variations and adaptiveness to diversified environments. The secretion of sticky latex, a pair of stipules or a stipule sheath to protect the young branches, and a "tri-veined" shape where the basal lateral veins of the leaves exhibit an oblique orientation and form acute angles with the central vein, are the main traits of the majority of *Ficus* trees (Yuan et al., 2024).

Ficus species, such as *Ficus racemosa* Linn., belonging to the family Moraceae, are widely valued for their medicinal and nutritional properties. *Ficus racemosa* Linn., syn *Ficus glomerata* Roxb., it is commonly known as the Cluster Fig, Gular, or Indian Fig tree, and stands out as a particularly significant species due to its profound ethnobotanical importance and diverse pharmacological activities. Belonging to the Moraceae family, *F. racemosa* is widely distributed in India (Himalayan ranges from Punjab, Khasia mountains, Maharashtra, Bihar, Orissa, West Bengal, Rajasthan, Deccan and South India) and the world (Australia, Malaysia, Burma, China, Indonesia) (Ahmed and Urooj, 2010; Chaware et al., 2020). Stem and bark are utilized as tea (Ahmed et al., 2010). In Africa, the traditional liquor is obtained from the fruit of *F. racemosa* (Bhalerao et al., 2014). *F. racemosa* is considered a sacred tree in Hinduism. It is often associated with divine significance, symbolizing abundance and prosperity. Ancient Vedic texts, such as the Atharvaveda, mention the Udumbara tree as a source of wood for rituals and amulets. Almost every part of the plant, from the leaves and fruits to the roots and bark, is used medicinally in India's many traditional medical systems, such as Ayurveda, Unani, and Siddha. The bark, in particular, holds a prominent position in traditional pharmacopoeias, recognized for its efficacy in treating a wide spectrum of ailments. Traditional practitioners have historically employed *F. racemosa* bark as an astringent for gum diseases, a decoction for managing dysentery, menorrhagia, and diabetes, and skin



conditions such as boils, inflammation, and ulcers (**Ahmed and Urooj, 2010**). A thorough empirical grasp of its medicinal characteristics is further demonstrated by the fact that its traditional uses include the treatment of fever, leprosy, vomiting, liver diseases, heart disease, hyperlipidemia, and cough, pneumonia, and pertussis. The remarkable array of traditional uses suggests a complex interplay of bioactive compounds within the bark. Modern scientific investigations have begun to unravel this complexity, revealing a rich phytochemical analysis that includes flavonoids, phenolic acids, steroids, saponins, coumarins, tannins, and triterpenoids. Bark contains different compounds such as β -sitosterol, β -sitosterol-D-glucoside, dextran acetate, leucopelargonidin-3-O- α -L rhamnopyranoside, β leucopelargonidin-3-O-beta-D-glucopyranoside, leucocyanidin-3-O- β -D-glucopyranoside, ceryl behenate, α -coumarin acetate, β , leucocyanidins, kaempferol, coumarin, ellagic acid, α -coumarin, stigmasterol, bergen. ellagic acid, α -coumarin, β -amyrin, stigmasterol, bergenin. Leaves contain campesterol, arabinose, bergamot, psoralen, eicosanol, n-octasanol acetate, racemic acid, quercetin-3-glucoside, rutin and leucocyanidin methyl ester. Tetracyclic triterpene, glauanol acetate-characterized as 13 α , 14 β , 17 β H, 20 α H-lanosta-8, 22-diene-3 β -acetate along with racemosic acid, was isolated from the leaves (**Paarakh, 2009; Ahmed and Urooj, 2010; Bhalerao et al., 2014; Shabab et al., 2021**). Phenolic substances like gallic and ellagic acids are found in fruit. Hentriacontane, β -sitosterol, glauanol, glauanol acetate, tiglic acid, lupeol acetate, friedelin, esters of taraxasterol, higher hydrocarbons, and other phytosterols were discovered from fruit. Latex contains euphorbinol, isoeuphorbol, cycloartenol, cycloeuphordenol, 4-deoxyphorbol euphol, palmitic acid, α -amyrin, and β -sitosterol, taraxerol, trimethyl ellagic acid, tinyatoxin (**Bhalerao et al., 2014; Bhogaonkar et al., 2014; Chaware et al., 2020; Pahari et al., 2022; Kale et al., 2023**). An acute toxicity study in rats demonstrated that the aqueous extract of the bark is safe at doses up to 2000 mg/kg of body weight. No significant abnormalities were observed in histopathological examinations or biochemical markers, indicating a favorable safety profile (**Solanki and Bhavsar, 2014**).

These diverse classes of compounds are believed to be responsible for the many pharmacological activities. Preliminary studies have already validated several traditional claims, demonstrating the bark's significant antidiabetic, anti-inflammatory, antioxidant, antimicrobial, and hepatoprotective properties. For instance, research has shown its capacity to significantly



reduce blood glucose levels, alleviate inflammatory responses, neutralize harmful free radicals, and protect liver cells from damage. In addition to its therapeutic uses, *F. racemosa* is an important ecological plant. It is essential to preserving biodiversity since it is a keystone species in many habitats, especially riparian zones. Its distinctive syconia, or figs, are an essential food source for many different kinds of frugivorous creatures, including as bats, birds, and other mammals, which helps spread seeds and promote forest regeneration. Moreover, its extensive root system helps in soil stabilization, preventing erosion and promoting ecological balance. This integrated study aims to provide a comprehensive phytochemical and pharmacological profiling of *F. racemosa* bark, bringing together its rich ethnobotanical history with modern scientific validation and acknowledging its critical ecological importance. By bridging traditional knowledge with contemporary research, this study seeks to further elucidate the therapeutic potential of *F. racemosa* bark and promote its sustainable utilization for both human health and ecosystem well-being (Mandal et al., 2000; Deep et al., 2013; Sharma et al., 2023).

MORPHOLOGY

It is a large moderate sized tree with few short aerial roots, bark grey to rusty. Leaves ovate, ovate – lanceolate or elliptic, 7-20 x 3.5 – 9 cm, entire, obtuse, acute or subacute, dark green above, paler beneath, glabrous above, glabrous or pubescent on the nerves beneath, base obtuse or rounded, rarely acute, 3-nerved, secondary nerves 4-8; petiole 1.6- 6 cm long; stipules ovate – lanceolate, 1.2- 2.5 cm long. Figs on short or sometimes up to 60 cm long leafless, scariously bracteolate, tubercled and warted branchlets from the main trunk or larger branches, figs occasionally axillary, globose to pyriform, 2.6 – 6 cm diam., red when ripe, pubescent or tomentose; peduncle up to 1.8 cm long. Male, female and gall flowers in the same fig. Male flowers near the mouth; tepals 3-4; inflated. Perianth of gall and female flowers toothed. Stigma clavate. Achene granulates (Saxena and Brahmam, 1995; Figure 1-3).



Figure 1: Leaves of *F. racemosa*



Figure 2: Fruits of *F. racemosa*

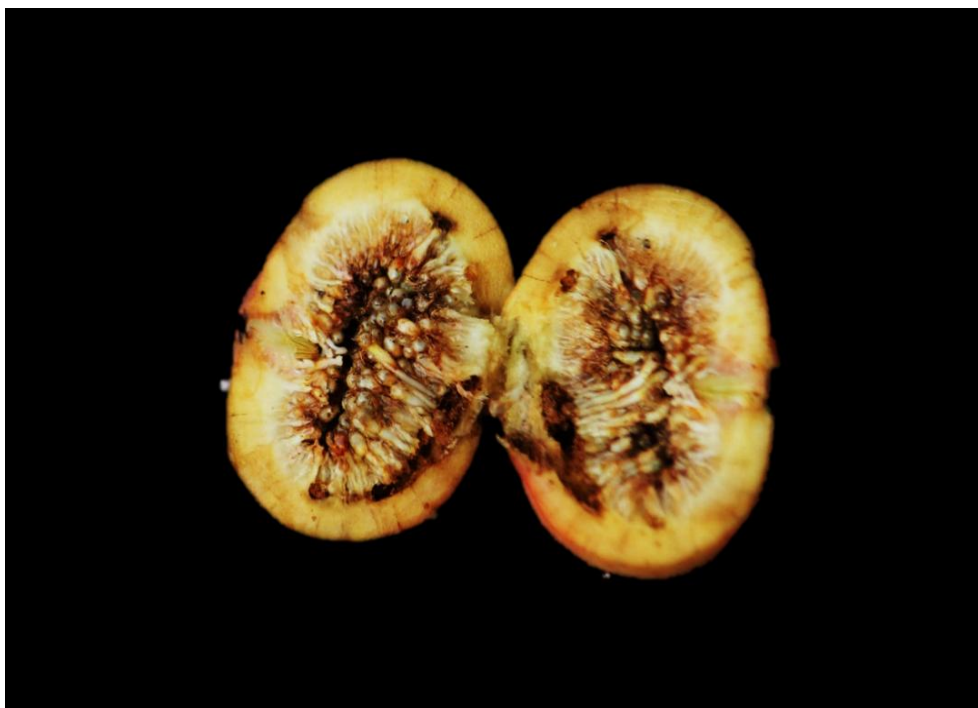


Figure 3: Syconium of fruit of *F. racemosa*

METHODOLOGY

The bark of *F. racemosa* was collected from the nearby Mahanadi River area of Cuttack district of Odisha, India. The plant species was identified by the authors (**Figure 4; Nayak and Kumar, 2023**). The Soxhlet extraction method was adopted using three extract for phytochemical analysis (**Marndi et al., 2024**). Detection of nine secondary metabolites was conducted using standard methods (**Kumar et al., 2013; Marndi et al., 2024**).

Qualitative phytochemical analysis (Marndi et al., 2024; Jena et al., 2025)

Test for tannin: About 1 ml of the bark extract was taken. Three to five drops of 10% lead acetate solution were added. The gelatinous precipitate formation confirmed the presence of tannin.

Test for saponin: About 1 ml of the bark extract was taken and 1 ml of distilled water was added and shaken well. The formation of persistent froth was observed confirming the presence of saponin.



Test for flavonoids: About 1 ml of the bark extract was taken. Two ml of 2% NaOH solution and 3 to 4 drops of dilute HCl were added. The colour initially turned to an intense yellow colour with NaOH solution and later became colourless. This colour changes in appearance confirmed the presence of flavonoids.

Test for terpenoids: About 1 ml of the bark extract was added with 5-6 drops of chloroform and placed in the water bath for a few minutes. Then 5-6 drops of concentrated sulphuric acid were added. The reddish-brown interface confirmed the presence of terpenoids.

Test for phenolic groups: About 1 ml of the bark extract was taken. A few drops of 5% ferric chloride solution were added. The dark bluish-black appearance confirmed the presence of phenolic compounds.

Test for reducing sugars: About 1 ml of the bark extract was taken and 2 drops of Fehling's solution A followed by equal amount of Fehling's solution B were added and kept in the water bath for some time. The presence of red-orange precipitate confirmed the presence of reducing sugar.

Test for steroids: About 1 ml of the bark extract was taken. 1 ml of chloroform and 1 ml of concentrated sulphuric acid was added to it. The appearance of a red color in the upper layer and a yellow color with green fluorescence in the lower layer indicated the presence of steroids.

Test for alkaloids: About 1 ml of the bark extract was taken and 3 to 4 drops of Dragendroff's reagent were added. The formation of a reddish-brown precipitate confirmed the presence of alkaloids.

Test for carbonyl compounds: About 1 ml of the bark extract was taken and 3 to 4 drops of 2,4- Dinitrophenylhydrazine (DNPH) reagent was added. The formation of yellow crystals confirmed the presence of carbonyl compounds.

RESULTS AND DISCUSSION

During the present study focusses on bark in three extract such as N- hexane, methanol, and ethanol extract. It was observed the bark contain tannin, saponin, terpenoids, reducing sugars and alkaloids. Tannin, phenolic compounds, alkaloids and saponin are present in ethanol and methanol extract. Reducing sugars is present in three extracts. Terpenoid is present in ethanolic extract (**Table 1; Figure 5-7**). Tannin may be responsible for



astringent effects. Phenolic compounds may be responsible for antioxidant activity. Saponin may be responsible for anti-inflammatory activity. Terpenoids may be responsible for antimicrobial and analgesic activity. Reducing sugars may be responsible for antioxidant activity (**Table 1**). Tannin, saponin, phenolic compounds and alkaloids are not found in the non-polar solvent extracts of *F. racemosa* barks but found in moderate polar solvents are expected for the biological activities.

Table 1: Phytochemical screening of *F. racemosa* bark

Bioactive compounds	N- Hexane extract	Ethanol extract	Methanol extract
Tannin	-	+	+
Saponin	-	+	+
Flavonoid	-	-	-
Terpenoids	-	+	-
Phenolic compounds	-	+	+
Reducing sugars	+	+	+
Steroids	-	-	-
Alkaloids	-	+	+
Carbonyl compounds	-	-	-

(+ve – Positive; -ve – Negative)



Figure 4: Bark of *F. racemosa*

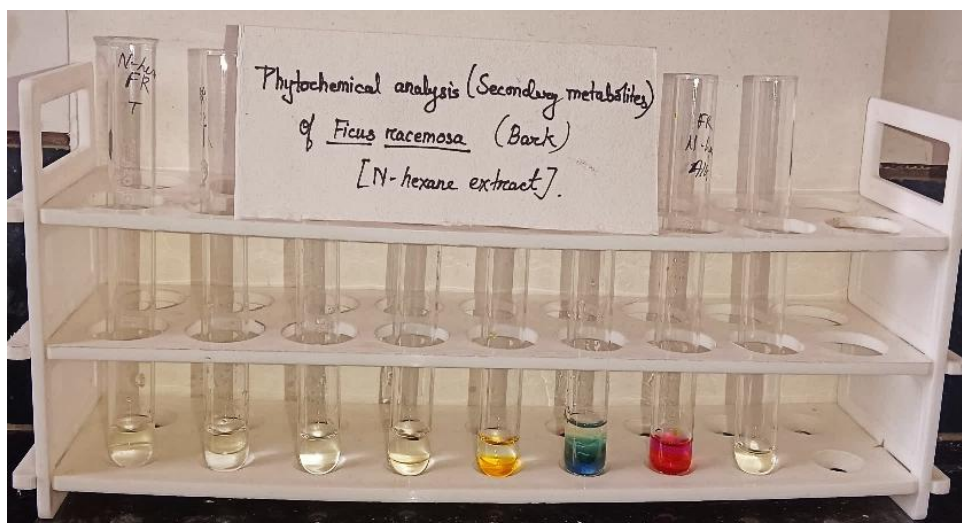


Figure 5: Phytochemical analysis (Secondary metabolites) of *F. racemosa* (Bark) of n- hexane extract

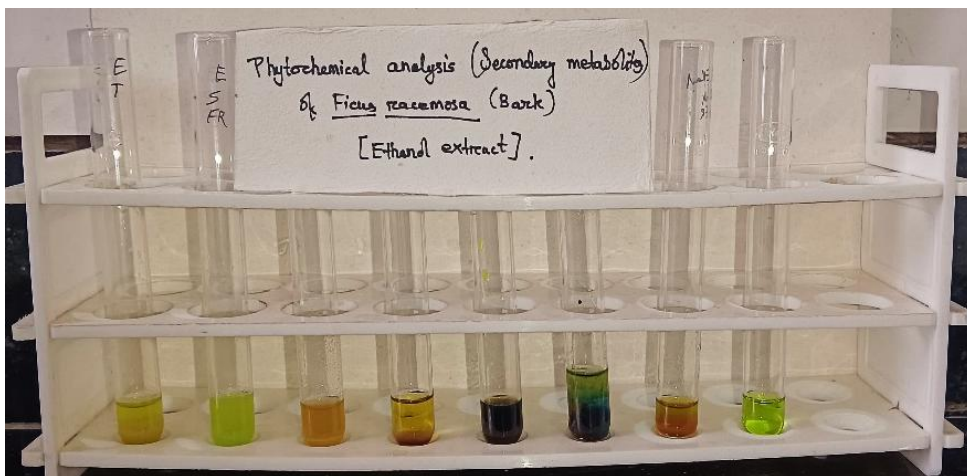


Figure 6: Phytochemical analysis (Secondary metabolites) of *F. racemosa* (Bark) of ethanol extract

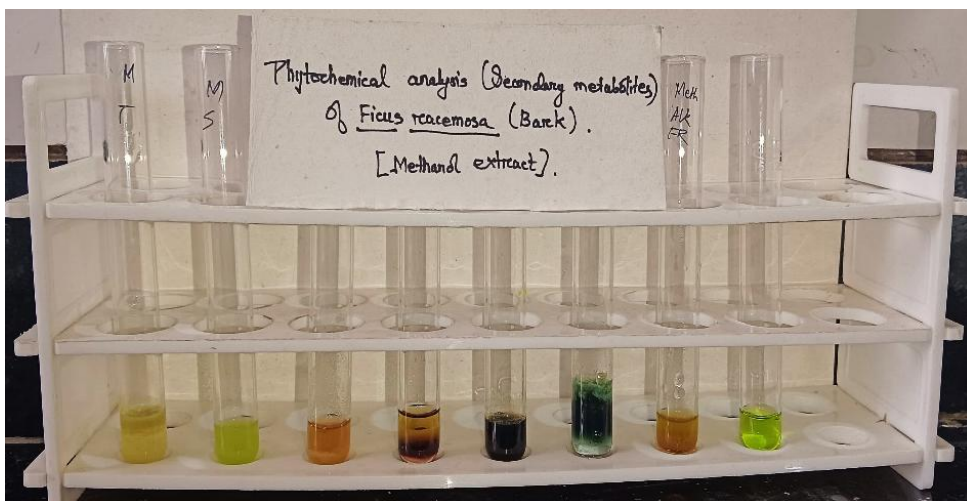


Figure 7: Phytochemical analysis (Secondary metabolites) of *F. racemosa* (Bark) of methanol extract

During the theoretical survey it was revealed that ripen fruit is consumed to treat diabetes and bark paste is applied to treat wound. In Table 2, it clinched that mostly root, bark, fruits, latex and leaves are used to treat various ailments. The specific modes of use include decoction, infusion, juice, paste, and consumption in raw form.



Table 2: Ethnomedicinal uses of *F. racemosa*

Plants parts	Mode of uses	Diseases	Sources
Bark	Infusion	Gum problem	Awasthi and Dixit, (2023)
Bark	Infusion	Dysentery	Kale et al., (2023)
Bark	Decoction	Hemorrhoids	Kale et al., (2023)
Bark	Decoction	Piles	Deep et al., (2013)
Fruit and bark	Infusion	Leprosy	Ahmed and Urooj; (2010); Kale et al., (2023)
Fruits	Decoction	Visceral obstruction	Ahmed et al., (2010)
Fruits	Decoction	Constipation	Ahmed et al., (2010); Ahmed and Urooj, (2010)
Latex	Decoction	Boils	Awasthi and Dixit, (2023)
Latex	Paste	Fractures	Kale et al., (2023)
Leaves	Decoction	Biliary tract infections	Ahmed and Urooj, (2010); Kale et al., (2023); Kohale et al., (2024)
Leaves	Decoction	Dysmenorrhea	Kale et al., (2023)
Leaves	Paste	Blisters	Kunwar and Bussmann, (2006); Ahmed and Urooj, (2010); Kale et al., (2023);



Leaves	Infusion	Menorrhoea	Kunwar and Bussmann, (2006)
Ripen fruit	Raw	Diabetes	Kale et al., (2023)
Root	Decoction	Tonsillitis	Ramakrishna et al., (2023)
Roots	Paste	Wounds	Murti and Kumar, (2012)
Sap	Decoction	Gonorrhea	Ramakrishna et al., (2023)
Stem	Juice	Stomach ache	Kunwar and Bussmann, (2006)

In Table 3, mostly bark and leaves possess antidiabetic, antioxidant, antidiarrheal, antipyretic, antitussive, analgesic activity. In this table, it summarizes the different plants parts possess pharmacological effects.

Table 3: Pharmacological activities of *F. racemosa*

Parts used	Pharmacological activities	Sources
Bark and leaves	Antidiabetic activity	Ahmed and Urooj, (2010); Amin et al., (2015); Awasthi and Dixit, (2023);
Bark	Antioxidant activity	Awasthi and Dixit, (2023); Sharma et al., (2023)
Bark	Antidiarrheal activity	Ahmed and Urooj, (2010); Awasthi and Dixit, (2023)
Bark	Antipyretic activity	Ahmed and Urooj, (2010); Awasthi and Dixit, (2023); Sharma et al., (2023);
Bark	Antitussive activity	Kale et al., (2023); Sharma et al., (2023)



Bark and leaves	Analgesic activity	Awasthi and Dixit, (2023)
Bark, fruits and leaves	Gastroprotective activity	Ahmed and Urooj, (2010); Awasthi and Dixit, (2023); Kale et al., (2023)
Fruits	Anti-filarial activity	Awasthi and Dixit, (2023)
Leaf bark	Larvicidal	Bhalerao et al., (2014)
Leaves	Hepatoprotective activity	Mandal et al., (1999); Awasthi and Dixit, (2023); Kale et al., (2023)
Leaves	Hypotensive activity	Ahmed and Urooj, (2010)
Leaves	Anti-inflammatory activity	Mandal et al., (2000); Awasthi and Dixit, (2023); Sharma et al., (2023)
Stem, bark and root	Antibacterial activity	Pingale et al., (2019); Awasthi and Dixit, (2023); Chaware et al., (2020)
Stem bark	Antifungal activity	Pingale et al., (2019); Awasthi and Dixit, (2023)
Stem bark	Hypoglycemic activity	Kale et al., (2023)
Stem bark	Wound healing	Bhalerao et al., (2014)

ECOLOGICAL FACTORS

Figs are a critical food source for a wide range of animals, making it a keystone species in many tropical ecosystems (Pothasin et al., 2014). It serves as a food plant for the caterpillars of the butterfly the two – brand crow (*Euploea Sylvester*) of northern Australia (Bhalerao et al., 2014). Asian elephant feeding on ripe fruit, bark and leaves particularly along riverbanks



(Kunwar and Bussmann, 2006; Mohapatra et al., 2012; Koirala et al., 2016). Bats are crucial seed dispersers their ingestion often enhances seed germination (Tang et al., 2007). Indian giant flying squirrel also consumed the leaves and ripen fruits (Nandini and Parthasarathy, 2008). Fig wasps (*Ceratosolen fusciceps*) are highly specialized, obligate pollinators. They don't consume it like other animals, but it provides the essential environment and resources for developing wasp larvae inside the syconium (Ramakrishna et al., 2023).

CONCLUSION

Present study highlights the profound significance of *Ficus racemosa* bark, not only as a repository of diverse phytochemicals with validated pharmacological activities but also as a plant deeply embedded in traditional medicine and critical for ecological balance. Flavonoids, tannins, and phenolic acid were among the many bioactive substances found in the bark, according to the phytochemical profiling. The phytochemical profiling revealed the presence of a rich array of bioactive compounds in the bark including flavonoids, tannins, phenolic acid. These compounds collectively underpin the bark's extensive therapeutic potential. Keeping this mind, an attempt has been made to summarize the phytochemical, ethnomedicinal, pharmacological activities and ecological importance. Systematic research, including clinical validation and drug development, can pave the way for its integration into evidence-based medicine.

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