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Ethnopharmacology: An Innovative Approach for the Treatment of Jaundice Using Traditional Medicinal Systems

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ABSTRACT

Jaundice is a widespread disease in neonates and adults, and it is particularly prevalent in underdeveloped countries. It is linked to the most common liver disorders due to the dysfunction of the liver, such as hepatitis and cirrhosis, and can be associated with factors like viral infections and autoimmune disorders. The data concerning aspects of our study were extracted using the terms "Jaundice, Causative factor, Traditional medicine, Pharmacological activities, Bioactive constituents". Various search engines, such as PubMed, Google, Scopus, Google Scholar, Science Direct, and Web of Science, were used (2017-2025). This review shows that approximately 34 medicinal plants used by tribal and rural inhabitants of India are used to treat jaundice. In Ayurveda, herbs such as Arogyavardhini Vati, Punarnava, and Bhumyamalaki are commonly used for the treatment of jaundice due to their hepatoprotective properties, which aid liver detoxification. Amongst all the plant species, the most effective traditional plants for treating jaundice include E. ribes, H. helix, J. adhatoda, B. aristata, A. vera, and T. cordifolia. These traditional medicinal systems often combine multiple herbs to create formulations that target various aspects of jaundice, from reducing bilirubin levels to promoting liver health. Some of these herbal compounds have shown promising results in preclinical studies, and clinical trials are underway to assess their safety and efficacy. While modern medical treatments for jaundice, such as phototherapy and medications, have proven efficacy, ethno-pharmacological approaches offer alternative options, particularly in regions where access to advanced healthcare is limited.

Keywords: *Jaundice, Traditional medicine system, Pharmacological activities, Bioactive constituents*

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INTRODUCTION

Jaundice, recognized as Icterus, is a commonly widespread disease of neonates and adults, especially in underdeveloped countries across the globe (Tewari *et al*., 2017; Mehrzad *et al*., 2022; Sakhnenkova *et al*., 2023). Generally, the term jaundice is acquired from the French word "Jaune", which signifies "yellowness" accentuated by yellow pigmentation (Janghel *et al.,* 2019; Shoghi & Kian, 2022; Huyen *et al*., 2023; Petronis *et al*., 2023; Cantile *et al*., 2024). The incidence of newborn jaundice has been estimated at 100,000 or more cases; this impacts 130,000 or more infants per annum, especially when associated with the high risk of kernicterus syndrome (Hansen, 2021; Ouafa *et al*., 2022; Kartashev *et al*., 2023). According to the National Center for Biotechnology Information (NCBI), approximately 60% to 80% of healthy infants are likely to suffer from jaundice (Ansong-Assoku, 2024). The National Institutes of Health (NIH) in 2019 stated that neonatal hyperbilirubinemia was the leading cause of hospitalization, with an estimated 60-80% of newborns affected (Olusanya *et al.,* 2018; Anand, 2020). Clinically, bilirubin levels in the blood are typically under 1 mg/dL, while levels over 2-3 mg/dL typically engender jaundice (Tewari *et al.,* 2017). Bilirubin is a yellow pigment found in red blood cells. When those cells die, the liver filters them from the bloodstream. If our liver can't function properly, bilirubin levels can rise, and the skin can turn yellow. This condition is defined as hyperbilirubinemia (Janghel *et al.,* 2019). Besides, in neonates, jaundice gives rise to kernicterus and acute bilirubin encephalopathy, together with a significant threat to the mortality rate. It ultimately becomes a risk factor for long-term neurodevelopmental impairments (Olusanya *et al.,* 2018). Historically, jaundice was seen as an indication of "causeless hatred" in the Babylonian Talmud and was described in ancient Ayurveda and the Indian traditional system. Moreover, the work of Hippocrates (460-370 B.C.) also gave the impression of this ailment (Tewari *et al.,* 2017). In the earliest literature, "iecur" is a Latin term used to refer to the liver (Raghuvanshi *et al*., 2021). The liver is the most essential organ, found only in vertebrates, that produces bile and metabolizes and detoxifies food, chemicals, and drugs. Toxic substances such as microorganisms, carbon tetrachloride, chemotherapeutic drugs, antibiotics, and chronic alcohol consumption lead to liver failure or dysfunction (Janghel *et al.,* 2019). These substances are the main cause of the various types of liver diseases/disorders, such as hepatitis A,

hepatitis B, hepatitis C, jaundice, cirrhosis, liver cancer, and hemolytic anemia etc. (Raghuvanshi *et al.,* 2021). Jaundice is one of the most prevalent amongst the various types of liver disorders (Janghel *et al.,* 2019). The major indications of jaundice in an individual include extreme weakness, headache and fever, loss of appetite, pruritus, vomiting, fatigue, abdominal pain, severe constipation, nausea, weight loss, yellow discoloration of the eyes, tongue, skin, and urine, and dull pain in the liver region (Janghel *et al.,* 2019). Several factors are responsible for the development of jaundice. It is frequently associated with viral hepatitis, medication-induced hepatitis, autoimmune hepatitis, gallstones, tumors, hemolytic anemia, drug-induced hepatitis, and various syndromes (Kumarasmy & Ramkumar, 2022). Based on these causative factors, the condition is primarily categorized into three groups.

Newborn or neonatal Jaundice (NJ) is the most common physiologic condition, occurring mostly in the fetus and characterized by yellowish discoloration of the skin, sclera, and conjunctiva. As a result, serum bilirubin levels are elevated in the early weeks of life (Hansen, 2021). Whenever there is an excess of bilirubin in the baby's blood, that condition is called hyperbilirubinemia (Olusanya *et al*., 2018; Janghel *et al*., 2019). Majorly, a family background of NJ enhances the possibility of jaundice in the upcoming generation and is one of the numerous examples of genetic problems that can happen (Hansen, 2021). Among all factors associated with neonatal deaths in the initial week of life, NJ ranked seventh worldwide and accounted for 1309.3 deaths per 100000 live births in 2016. The regions of South Asia and Sub-Saharan Africa are at the most significant risk of Jaundice (Olusanya *et al*., 2018).

In continuation, it can also cause serious conditions like coma, a sudden onset of illness or epileptic fits, and psychosis (like having a severe mental disorder), which eventually leads to a patient's death (Raghuvanshi *et al*., 2021). Jaundice in rare cases becomes more grievous in newborns, which may cause severe complications. Several risk factors are associated with NJ, such as preterm babies, babies with darker skin color, siblings with jaundice, feeding difficulty, bruising, breast milk Jaundice, and blood type, which is possibly a serious concern for the newborns (Dharani *et al*., 2024). To overcome these situations, proper treatment should be given to infants at the very initial stage of jaundice. To mitigate this ailment, various management strategies are requiredTherefore, in the current study, various medicinal plants were selected and described, which have long been valued for their traditional use in combating jaundice. Moreover, we also discussed the ethno-medical importance of several plants that have been used in Indian traditional systems, used by many indigenous people to cure jaundice, especially in neonates at an early age.

MATERIALS AND METHODS

This review illustrates that approximately 34 medicinal plants were used by tribal and rural inhabitants of India to cure jaundice. A total of 38 references (2017-2025 were selected and explained using comprehensive data approaches with the keywords "Jaundice, Causative factor, Traditional medicine, Pharmacological activities, Bioactive constituents". Various search engines, including PubMed, Google, Scopus, Google Scholar, ScienceDirect, Sci-Hub, and Web of Science, were used. The description of 34 medicinal plants, with scientific evidence supporting the folklore uses of some of them and their mechanisms of action, has been discussed. The pharmacological aspects of these medicinal plants are also described in this paper. We also documented the efficacy of traditional medicinal plants, as used in Ayurveda, Homeopathy, and Siddha systems, in treating jaundice.

Pathophysiology and metabolism of jaundice

There are three types of phases: viz., pre-hepatic phase, intra-hepatic phase, and post-hepatic phase, which may be involved in the pathophysiology of jaundice and its metabolism of bilirubin, as represented **(Figure 1)** (Janghel *et al*., 2019; Raghuvanshi *et al*., 2021).

Pre-hepatic jaundice

Pre-hepatic jaundice occurs due to rapid pathological elevation in the breakdown or rupture of RBC (hemolysis), overwhelming the liver's ability to adequately eliminate the enhanced bilirubin level from the bloodstream

Hepatic jaundice

Jaundice is attributed to the liver's ability to metabolize and excrete bilirubin properly.

Post-hepatic jaundice

Also known as obstructive jaundice, this occurs when the flow of conjugated bilirubin in the form of bile from the liver to the intestines is disrupted

Jaundice is a more serious illness, usually in adults rather than in neonates, and most often it causes even death of an individual (Janghel *et al*., 2019; Raghuvanshi *et al*., 2021). Bilirubin is produced within the body by the breakdown of aged red blood cells, which causes the release of hemoglobin in the reticuloendothelial cells of the spleen, liver, and bone marrow, where iron is liberated from hemoglobin along with carbon monoxide and biliverdin, which later gets transformed by biliverdin reductase to bilirubin, which remains in the body as a waste material. Usually, the liver filters this bilirubin from the blood and then eliminates it from the body through urine and feces after it is metabolized (Tewari *et al*., 2017; Janghel *et al*., 2019).

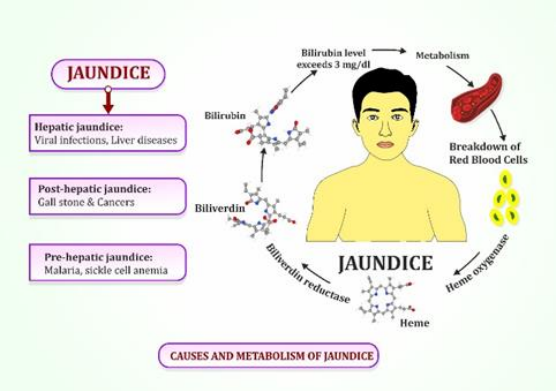

Figure 1. Causes and Metabolism of Jaundice

Medicinal plants used in jaundice

Even with the emergence of new synthetic medications in conventional medicine, there has been a growing interest in exploring medicinal plants and their use globally. The WHO stated that about 70-80 % of people rely on complementary medicine for their preliminary healthcare needs worldwide (Park *et al*., 2021; Raghuvanshi *et al*., 2021). In the study, several traditional healers used these ethnomedicinal plants as remedies for jaundice. The plant is used for the treatment of jaundice, and its ethnomedicinal uses are listed **(Table 1)**.

Table 1. Medicinal plants used in the treatment of jaundic**e**

S. No.	Family Names	Plant Names	Common Names	Parts Used	Preparations	References
1	Rutaceae	*Aegle marmelos* (L.) Correa	Bil, Bil patri	L, F	D	Raghuvanshi *et al*. (2021)
2	Liliaceae	*Aloe vera* (L.) Burm.f.	Kware, Ghritkurnar, Gavrapatha	L	PU, J	
3	Fabaceae	*Alhagi maurorum* Medik.	Mannatree, Shotoraranjabin	AP	D, S	Thajudeen *et al*. (2022)
4	Myrsinaoeae	*Ardisia japonica* (Thunb.) Blume	Marlberry	WP	ND	Tewari *et al*. (2017)
5	Meliaceae	*Azadirachta indica* A. Juss	neem tree	B	D	
6	Urticaceae	*Urtica dioica* L.	Bichu butti	WP	ND	
7	Betulaceae	*Betula utilis* D. Don	Bhojpatra	B, W, L, R	Not defined	Raghuvanshi *et al*. (2021)
8	Nyctaginaceae	*Boerhavia diffusa* Linn.	Punarnava	WP, R	E	Janghel *et al*. (2019); Raghuvanshi *et al*. (2021)
9	Crassulaceae	*Bryophyllum pinnatum* (Lam) Oken	Patharchata	L	ND	Janghel *et al*. (2019)
10	Capparaceae	*Capparis spinosa* L.	Kabra findus rose	F, SH	ST, PO	Raghuvanshi *et al*. (2021); Thajudeen *et al*. (2022)
11	Umblellifereae	*Centella asiatica* (L.) Urb.	Brahrni, Minki	WP	P	Raghuvanshi *et al*. (2021)
12	Cucurbitaceae	*Cucumis sativus* L.	Kheera	F	C	
13	Convalvulaceae	*Cuscuta reflexa* Roxb.	Akash bel	WP	D	
14	Solanaceae	*Datura stramonium* L.	Dhatura	L, SD, F	C	
15	Zingiberaceae	*Curcuma angustifolia* L.	Tikhur	RH	ND	Janghel *et al*. (2019)
16	Asteraceae	*Eclipta prostrata* Roxb.	Bhringaraj	L, WP	S, J	Tewari *et al*. (2017)
17	Boraginaceae	*Ehretia laevis* Roxb.	Chamror	L	S	
18	Flacourtiaceae	*Flacourtia indica* (Burm. F.) Merr.	Madagascar plum and Indian plum	R, L & F	P, D	
19	Equisetaceae	*Equisetum arvense* L.	Girthan	BR	J	Raghuvanshi *et al*. (2021)
20	Araliaceae	*Hedera helix* L.	Kannauri (Bail)	L	J	
21	Apocynaceae	*Hemidesmus indicus* (L.) R.Br.	Anantmool	R, B, L	ND	Janghel *et al*. (2019)
22	Lamiaceae	*Mentha arvensis* L.	Pudina	WP	ND	
23	Scrophulariaceae	*Picrorhiza kurroa* Royl ex. Benth.	Karru, Kutki	RH	PO	Raghuvanshi *et al*. (2021)
24	Rosaceae	*Prunus domestica* L.	Alubhukhara, Palam	F	E	
25	Pedaliaceae	*Sesamum indicum* L.	Til	L	PO	
26	Portulacuceae	*Portulaca oleracea* L.	Badinoni	WP, SD	S	Janghel *et al*. (2019); Thajudeen *et al*. (2022)
27	Punicaceae	*Punica granatum* L.	Daran, Aanar	F, L, WP, SD	PO	Raghuvanshi *et al*. (2021)
28	Brassicaceae	*Raphanus sativus* L.	Muli, Mura	L, ST R	J	Janghel *et al*. (2019)
29	Gramineae	*Saccharum officinarum* L.	lkha/Ganaa	L	J	
30	Fabaceae	*Tamarindus indica* Linn.	lmali, Tamr Hendi	L, FL, R, B, F	D	Raghuvanshi *et al*. (2021); Thajudeen *et al*. (2022)
31	Combretaceae	*Terminalia chebula* Retz.	Harad	F	PO	Raghuvanshi *et al*. (2021); Thajudeen *et al*. (2022)
32	Menispermaceae	*Tinospora cordifolia* (Willd.) Miers	Giloe,, Guljae	WP, ST, R	J	Janghel *et al*. (2019); Raghuvanshi *et al*. (2021)
33	Lythraceae	*Woodfordia fruticosa* (L.) Kurz	Dhoaien, Dhai	FL	E	
34	Poaceae	*Triticum aestivum* L.	Wheat	L, S	ND	Janghel *et al*. (2019)

R: roots, RH: rhizomes, WP: whole plant, L: leaves, LT: latex, ST: stem, F: fruit, SD: seeds, FL: flower, B: bark, AP: aerial parts, BR: branches, SH: shoot, W: wood, SB: stem bark, ND: Not defined, I: infusion, D: decoction, P: paste, PO: powder, E: extract, J-Juice, S-Syrup

Pharmacological activities of medicinal plants

Traditionally, very few pharmacological interventions have been explained so far. In this regard, various studies have been conducted that explain the role of these herbal plants in the treatment of NJ with science-based pharmacological approaches. The plant part, extract, compounds, and their doses, route of administration, and mechanism of action were tabulated appropriately **(Table 2)**.

Table 2. Pharmacological activities of medicinal plants with their active constituents

S. No.	Plants	Parts used	Extract/ Dose	Method/route of administration of Extract	Animal Model	Results	Active constituents	References
1	*Aegle marmelos* (L.) Correa	L	Ethanol extract (25 & 50 mg/kg) in combination with piperin	CCl_4-model	Wistar albino rats	The extract (25 mg/kg) did not significantly reverse hepatotoxicity. However, a low dose of this plant, combined with piperine, showed a significant reversal of hepatotoxicity compared with the CCl_4 group.	Alkaloids, Carbohydrates, Flavonoids, Tannins, Phenolic compounds, and Phytosterols	Rathee *et al*. (2018)
2	*Alhagi maurorum* Medik.	WP	*A. maurorum* ethanolic extract (AME: 300 mg/kg)	Concanavalin A (Con A)-induced hepatitis (CIH)	Swiss albino mice	AME has a hepatoprotective effect in concanavalin A (Con A)-induced hepatitis (CIH) in mice.	Polyphenol, Ellagic acid, Gallic acid, Ferulic acid, Methyl gallate, and Naringenin	El-Mahdy *et al*. (2024)
3	*Ardisia japonica*(Thunb.) Blume	WH	Aqueous Extract	Acute immune liver injury induced by Con-A	Sprague-Dawley male rats	Treatment with the extract significantly alleviated ALT and AST levels in Con A-induced acute liver injury in a dose-dependent manner. Extracts at low and high doses alleviate oxidative stress-induced changes in MDA and SOD levels following acute injury in rat liver tissue.	Not known	Fu *et al*. (2022)
4	*Berberis asiatica* Roxb. ex. DC.	R	Berberine (5, 10 & 20 mg/kg,.)	Acute hepatotoxicity induced by CCl_4	Albino rats	In both the pre-treatment and post-treatment groups with berberine, serum ALT, AST, and ALP activities decreased in a dose-dependent manner.	Berberine	Raghuvanshi *et al*. (2021)
5	*Boerhavia diffusa* Linn.	L	Crude hydro-alcoholic extract of n-hexane, chloroform, ethyl acetate, and water fractions, Eupalitin-3-O-β-D-Galactopyranoside	CCl_4-induced toxicity in HepG2 cells	Rats	The hydro-alcoholic extract (80%) showed the highest concentration of eupalitin-3-O-β-D-galactopyranoside among the extracts. Purified eupalitin-3-O-β-D-galactopyranoside (1000 µg/mL), chloroform fraction (1000 µg/mL), and ethyl acetate fraction(500 µg/mL) showed hepatoprotective activity with 70.23 %, 23 % & 42 %, respectively.	Eupalitin-3-O-β-D-Galactopyranoside	Thajudeen *et al*. (2022)
6	*Capparis spinosa* L.	L	Hydro-alcoholic extract (100, 200 & 400 mg/kg)	Liver protection against t-BHP-induced hepatic injury	Mice	Pre-treatment with *C. spinosa* and Quercetin significantly recovered the levels of GSH depletion produced by t-BHP.	Not known	Kalantari *et al*. (2018)

7	*Centella asiatica* (L.) Urb.	WP	*C. asiatica* 50% ethanol extract (CA-HE: 50, 100 & 200 mg/kg)	Acetaminophen-induced acute liver injury	BALB/c mice	*C. asiatica* 50% ethanol extract (200 mg/kg) significantly decreases ($p<0.05$) the levels of AST, ALT, and lactate dehydrogenase, which are biomarkers of liver injury. *An in vivo* study showed that CA-HE50 prevented APAP-induced hepatic tissue injury in BALB/c mice.	Triterpenoids, Asiaticoside	Park *et al.* (2021)
8	*Curcuma angustifolia* L.	RH	Methanol extract of Rhizome of *C. angustifolia* (MECA) *in vitro* and *in vivo*.	CCl_4-induced hepatic damage	Swiss Albino rats	MECA attenuated the CCl_4-induced hepatotoxicity in HepG2 cells and Swiss albino rats while significantly restoring the levels of ALT, AST, and ALP, TP and albumin in comparison with the CCl_4 group.	α-tocopherol, Phytol, Squalene, β-sitosterol, Eugenol, Curcumenol, β-elemene, and Eucalyptol	Jena *et al.* (2019)
9	*Cuscuta reflexa* Roxb.	WP	Ethanolic extract (200 & 400 mg/kg)	DMH-treated animals	Albino Wistar Rats	Ethanolic extract (200 & 400 mg/kg) treated animals significantly ($p<0.05$) decreased the SGPT level, while no significant reduction in the increase of SGOT level.	Not known	Mishra *et al.* (2022)
10	*Datura stramonium* L.	L	Ethanol extract	Alloxan-induced Diabetic	Albino Rats	The mean activities of serum AST, ALT, ALP, and total bilirubin in diabetic rats were significantly different from those in normal subjects. The extract did not show any harmful effects on the liver.	Not known	Alum *et al.* (2022)
11	*Ehretia laevis* Roxb.	L	Aqueous fraction (AFEL) and methanol extract of *E. laevis* (MEEL)	paracetamol (3 g/kg)-induced hepatotoxicity	Rats	Treatment with AFEL (25, 50 & 100 mg/kg) decreases serum hepatic marker levels and attenuates oxidative stress, inflammation, and histopathological changes compared to MEEL in PCM-induced hepatotoxicity.	Rutin, Quercetin and Kaempferol	Singh *et al.* (2024)
12	*Emblica ribes* Burmf	F	Ethanolic extract (100 & 200 mg/kg)	D-galactosamine (D-GalN) induced hepatotoxicity	Male and female Wistar rats	The pre-treatment extracts (100 & 200 mg/kg) significantly ($p<0.05$ & $p<0.01$) prevented the D-GalN-induced alterations in serum liver marker enzymes such as SGOT, SGPT, and ALP.	Not known	Parimala *et al.* (2023)
13	*Flacourtia indica* (Burm. F.) Merr.	L & SB	Ethanolic Extract	Blood and liver in aluminum chloride ($AlCl_3$) challenged	Wistar rats	Treatment with leaf and bark extract (500 or 625 mg/kg) significantly suppresses improved ALT, AST, and ALP activities, as well as BIL, TP, and blood glucose levels. Both extracts significantly improved the ALB in $AlCl_3$-challenged rats.	Not known	Idoko *et al.* (2024)

14	*Gentiana kurroo* Royle	RH	Hydroethanolic extract (GKRE)	Alcohol-induced liver injury	Rats	GKRE improved ($p<0.05$) the body and liver weights in ethanol-treated rats. It increases the mRNA levels of ADH, SREBP1c, liver damage markers, lipid peroxidation, and antioxidant enzymes in liver tissues. Moreover, GKRE decreases the expression of fibrotic markers (TGFβ, αSMA, and SMADs) and inflammatory markers (TNFα, IL6, IL1β, and NFκB) in the liver.	tannins, alkaloids, glycosides, saponins, terpenes, flavonoids, phenolics, and carbohydrates	Choubey *et al*. (2024)
15	*Picrorhiza kurroa* Royl ex. Benth.	RH	Methanol extract (125, 250 & 500 mg/kg), Ethyl acetate-soluble, methanol-eluted, water-eluted fractions (125 & 250 mg/kg), and compounds Picroside I, II, catapol & androsin (50 & 100 mg/kg)	D-galactosamine (D-GalN)/lipopolysaccharide (LPS)-induced liver injury.	Mice	The extract (500 mg/kg/os (p.o.) significantly inhibited the increase in serum levels of (sAST) and (sALT). Among all compounds, picroside II (50 mg/kg, p.o.) showed hepatoprotective activity with 74.7 & 74.0 % inhibition for sAST and sALT levels, respectively.	Picroside I, II, catapol & androsin	Sakamoto *et al*. (2023)
16	*Portulaca oleracea* L.	AP	*P. oleracea* extract (Low dose:25,medium dose: 50 & high dose: 100 mg/kg) and bifendate (3.75 mg/kg)	Acute alcoholic liver injury in rats	Wistar rats	The extract) significantly reduced the ALT, AST, ALP, and TG levels in the group compared to the ALI group.	Rutin, Hesperidin, Myricetin, Quercetin, Flavonoids.	Qiao *et al*. (2019)
17	*Punica granatum* L.	L	Aqueous extract (250 & 500 mg/kg b. w.)	CCl_4-induced hepatotoxicity	Male Wistar rats	Aqueous extract significantly increases total protein while reducing serum AST, ALT, and ALP levels compared to CCl_4-treated rats.	Alkaloids, Flavonoids, Saponins, Tannins, and Phenolic Compounds	Kumar *et al*. (2018)
18	*Raphanus sativus* L.	R	Methanolic Extract	Paracetamol-induced hepatotoxicity/oral	Albino rats	The levels of TBARS, SGOT, and SGPT were decreased, and glutathione level was significantly increased in the treated group.	Not known	Janghel *et al*. (2019)
19	*Saccharum officinarum* L.	L	Sugarcane leaf ethanol extract (SCLE: 300, 400 & 500 mg/kg)	Liver acute injury induced by CCl_4	Wistar strain rats	SCLE (500 mg/kg) decreases AST, ALT, ALP, and bilirubin levels compared with the negative control.	Not known	Dewi *et al*. (2021)
20	*Tamarindus indica* Linn.	SB	Ethanolic extract (100 & 200 mg/kg b.wt)	Drug-induced hepatic damage (DIHD)	Sprague Dawley rats	It significantly restored the liver-specific enzymes and biochemical markers altered by the co-administration of anti-tubercular drugs isoniazid (50 mg/kg b.wt.) and rifampicin (50 mg/kg b.wt.) to normal levels in a	Not known	Meena *et al*. (2018)

					dose-dependentmanner.			
21	*Terminalia chebula* Retz.	F	Chebulinic acid (CA)	Hepatotoxic models of cells, zebrafish larvae, and Mice were exposed to tert-butyl hydrogen peroxide (t-BHP), acetaminophen , and CCl_4, respectively.	Mice	Pre-treatment with CA prevented t-BHP-induced damage in L-02 hepatocytes by blocking the production. of ROS, reducing LDH levels, and enhancing HO-1 and NQO1 expression	Chebulinic acid	Feng *et al.* (2021)
22	*Triticum aestivum* L.	SH	*T. aestivum* extract: (100 or 200 mg/kg)	Acetaminophen-induced hepatotoxicity	C57BL/6 Mice	Pre-treatment with TAE (100 or 200 mg/kg) ameliorated acetaminophen -induced pathological damage (i.e., hepatotoxic lesions), reduced serum ALT and AST levels, and also ameliorated APAP-induced increased oxidative stress, thereby inhibiting oxidative liver damage and reducing the expression of inflammatory cytokines.	GABA and α-linolenic acid	Lim *et al.* (2021)
23	*Urtica dioica* L.	L	Phenolic extract (250 & 500 mg/kg)	CCL_4-induced hepatotoxicity	Male rats	Phenolic extract showed a hepatoprotective effect, with a significant increase in serum liver enzymes (ALP, ALT, AST) and bilirubin levels in CCl_4-induced hepatotoxicity compared with the control group.	Phenolic compound	Jawad *et al.* (2017)

Abbreviations: - R: Roots, RH: Rhizomes, L: Leaves, SH: Shoots, WP: Whole plant, H: Herbs, F: Fruits, SB: Stem Bark, AP: Aerial parts, WH: Whole Herb, ST: Stem, Carbon tetrachloride: CCl_4, Superoxide dismutase: SOD, Alanine transaminase: ALT, Aspartate aminotransferase: AST, Alkaline Phosphate: ALP.

Indian traditional medicinal systems

Owing to a lack of medical equipment, insufficient numbers of qualified physicians, and limited infrastructure, the benefits of the modern healthcare system cannot be extended to rural areas, so the traditional mode of treatment remains the first choice for many needy people.

Ayurvedic medicinal system

In Ayurveda, jaundice is known as Kamala, which is ascribed to an imbalanced pitta dosha, which affects the yakrit (liver). It is a natural treatment that addresses both the ailment and its underlying cause, as well as overall health. It is the oldest and most well-known treatment, as it ensures the best results with no negative consequences. According to Ayurveda, our bodies are protected by three vital forces: Vata, Pitta, & Kapha (Narayan, 2023). Kamala is classified as an apratyaksha (indirect) ailment in Ayurveda. A problem in the body results from a disruption in any of the three energies. The aggravation of pitta causes a liver disturbance. Ayurveda considers the abnormality of Ranjak pitta (a kind of pitta) to be a cause of jaundice. With the best jaundice treatment in India, it can completely eradicate the condition or start over. This naturalistic therapy for jaundice removes all doshas from the body and maintains the best stage of pitta in the body, which aids in the fight against jaundice. Some of the Ayurveda medicines used to treat jaundice are depicted in **(Figure 2; Table 3)**.

Table 3. Medicinal Plants Used in the Ayurvedic Traditional Medicine System

S. No.	Family Names	Plant names	Common names	Part used	Preparations	Medicinal uses	References
1.	Liliaceae	*Aloe barbadensis*	Aloe vera	Leaves	The leaves can be consumed as juice or as their pulp, and the pulp can be taken with water.	Jaundice	Raghuvanshi *et al.* (2021)
2.	Berberidaceae	*Berberis vulgaris*	Berberis	Herbs, Fruits	Liquid extract of the fruit	Chronic cases of jaundice	Tewari *et al.* (2017)
3.	Acanthaceae	*Hygrophila Auriculata*	Gokulakanta	Roots	A decoction of the herb in water is prepared	Hepatitis, Jaundice, Hepatitis dearrangement	Krishnaherbals (2022)
4.	Convolvulaceae	*Operculina turpethum*	Turpeth	Roots	Decoction, hepatitis, fevers, jaundice	Jaundice	www.planet.ayurveda.com

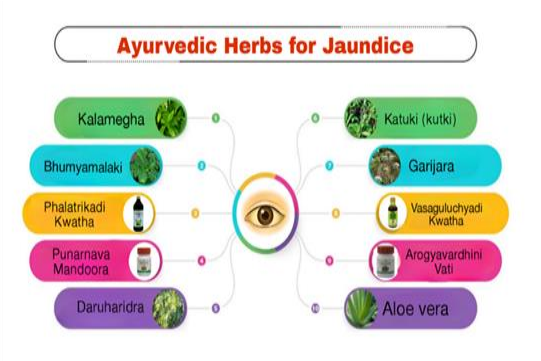

Figure 2. Ayurvedic herbs and medicines for the treatment of jaundice

Ayurvedic drugs

Ayurvedic jaundice treatment is currently the reliable, risk-free option. Jaundice can be treated with a variety of ayurvedic drugs, including Triphalachoorna, Bhoomyaamalaki (*Phyllanthus niruri*), Punarnavamandoor, etc., given as follows:

Kalamegha (king of bitters, green chirayta): It is useful in the treatment of jaundice, chronic fever, removing pitta, inducing purgation, and destroying worms. It also helps improve the function of the spleen and digestive system (Laxmidutta, 2019).

Bhumyamalaki (*P. niruri*): It is known to be useful in many liver disorders like jaundice. Due to its anti-inflammatory, antibacterial, and antispasmodic properties, it helps treat liver infections.

Phalatrikadi kwatha: It is useful in treating anemia and jaundice and helps strengthen and stimulate liver tissue, thereby making it an excellent hepatoprotective (liver-protecting) drug (Laxmidutta, 2019).

Punarnava mandoora: It is known to have cough and fever-reducing, rejuvenating, anti-inflammatory (reduces inflammation), diuretic properties, and to treat Jaundice (Laxmidutta, 2019).

Katuki (Kutki): It has a useful role in the deepana technique of shamanic chikitsa. It also promotes liver function and is helpful in removing pitta, regulating bile levels, and promoting purgation, thereby treating jaundice (Laxmidutta, 2019).

Garijara (Wild carrot): It has been used as a remedy for jaundice for a very long time.

Vasaguduchyadi kwatha: In Ayurveda, this kwatha is used to cure multiple disorders, such as jaundice (kamala), panduroga (anemia), and alcoholic liver disease.

Arogyavardhini vati: It is one of the multi-drug formulations used in combating hepatic dysfunction (Laxmidutta, 2019).

Aloe vera: This Ayurvedic herb is a gentle cleanser that detoxifies the kidneys and liver of accumulated toxins.

Some of the most helpful asanas used to treat this ailment include fish (Matsya) Asana (cough), sarvangasana (obesity), and many more (https://www.liveayurved.com).

Homeopathic medicinal system

Homeopathy is one of the holistic medicinal systems that originated in the late 1700s in Germany and is based on the principle that the body heals itself from disease (WebMD Editorial Contributors, 2023). A first thought behind Homeopathy is "like cures like". For example, something that triggers symptoms in a healthy person can address an illness with similar symptoms at a minimal dose, thereby triggering the body's immune response to counter the disease (WebMD Editorial Contributors, 2023). It is regarded as natural and safe, and its medicines are deep-acting with almost no side effects (Sharma, 2024). With a proper, nutritious diet, homeopathy can effectively cure jaundice at the earliest stage. Unlike conventional medicines, homeopathic medicines do not inhibit the ailment and its symptoms. They attack the illness at its root and trigger the body's restorative processes, making it strong enough to eradicate the disease. Suppressing the disease process makes it stubborn. Once the body's immune response is strengthened, it prevents further recurrence of the disease (Sharma, 2024).

Various effective homeopathic medicines such as Chelidonium, Phosphorus, Chelone, Myrica, Leptandra, Nux Vomica, etc., are used to cure jaundice **(Table 4)** (Sharma, 2024). Even though these homeopathic drugs are safe for both children and adults, and also safe for pregnant women. There are no contraindications in the homeopathic medicines.

Table 4. Medicinal plants used in the homeopathic traditional medicine system

S. No.	Homeopathic medicines	Common names	Medicinal Uses	References
1	Aconitum napellus	Monkshood	Jaundice	Narsaria (2019)
2	Arsenicum album	Arsenic Trioxide	Viral Infection, Enlargement of Liver and Spleen	
3	Belladonna	Deadly nightshade	Neonatal Jaundice	
4	Bryonia alba	Wild Hops	Jaundice	
5	Carduus marianus	St. Mary's thistle	Jaundice, Liver conditions	
6	Chelidonium majus	Celandine	Jaundice, Liver disorders	Sharma (2024); Narsaria (2019)
7	China officinalis	Peruvian bark	Liver pain, Jaundice, Weakness, and Exhaustion	
8	Nux vomica	Poison nut	Neonatal Jaundice, Jaundice and Diarrhea	
9	Phosphorus	Phosphorus	Jaundice, Hepatitis	
10	Lycopodium clavatum	Club moss	Swelling, Kidney, and Digestive Disturbances	Narsaria (2019)
11	Lupulus	Hop or hops	Neonatal Jaundice	Sharma (2024)

Siddha medicinal system

In the archaic texts of the Siddha Traditional Medicinal System, Jaundice is referred to as "manjal Kamalai" or "manjal Noi". Manjal means yellow, and Kamalai means a lack of interest, as the diseased person will lose interest in food, objects, and even routine activities (Narayan, 2023). It is also known as "pithu noi," which states that jaundice occurs mostly due to increased pitham, humor, and pithu neer (probably bile/bilirubin)

(Dharani *et al*., 2024). Humoral pathology of Peru Manjal Noi is an aggravation of pitta humor due to a person's intake of spicy and hot food in excess amounts; pitta levels inside the body will rise, which disturbs Iyyam humor and the function of Paravu Kaal Viyanan also (Kumarasmy & Ramkumar, 2022). The Siddha tradition is regarded as part of India's traditional system and is closely embedded in the Southern part of India, chiefly in Tamil Nadu, some plants are listed in **Table 5** (Archana *et al*., 2024). Siddha Classical formulations are effective in treating jaundice without altering the normal metabolism of the human body (Kumarasmy & Ramkumar, 2022). Generally, if one of the elements is in excess in the body, it may trigger an imbalance in the humor and lead to an illness. Therefore, the main focus of Siddha is to identify which humor is in excess and restore it to its normal level (Narayan, 2023).

Various siddhars used special therapies, such as Kayakarpam and Varmam, to treat jaundice in the old times. Some medications are likely to be useful in jaundice treatment, including Nellikaileghiyam, Irumbukitta chendooram, Iruppu chendooram, Silasithuparpam, Vediyuppu chunnam, Navachara chendooram, and Klaamegachendooram, which are given along with a suitable anubanam (vehicle), such as karisalai chooranam. Siddha is almost a safe and effective way to treat jaundice; unlike allopathy, it doesn't leave a long-lasting and detrimental effect on the human body (Narayan, 2023).

Table 5. Medicinal plants used for the treatment of jaundice in the Siddha Traditional Medicine System

S.No.	Botanical names	Common names	Tamil names	Part used	Modes of Administration	References
1	*Aegle Marmelos* (L.) Correa	Bael, Bhel	Vilvam	Leaves & Fruits	A decoction of leaves and unripe fruit	Raghuvanshi *et al*. (2021)
2	*Cynodon dactylon* (L.) Pers.	Bermuda grass	Arugampul	Leaves	One to two teaspoons of leaf juice is taken twice a day for a week.	Tewari *et al*. (2017)
3	*Cyperus rotundus* L.	Java grass, nut grass	Koraikilangu	Tubers	Root decoction with water is then given	
4	*Eclipta alba* (L.) Hassk.	Brhingraj, Bhangra	Karisalanganni	Leaves	The leaves are finely crushed and soaked overnight; the water is taken once per day in the morning or twice a day for 3-4 weeks; leaf and whole-plant juice.	
5	*Hemidesmus indicus* (L.)	Indian sarsaparilla	Nannari	Roots, Bark & Leaves	Root in jaundice and abdominal pain; leaves in eye infection and toothache.	Janghel *et al*. (2019)
6	*Leucas aspera* (wild.)	Thumbai or Thumba	Thumbai	Leaves	Juice of leaves and flowers mixed with milk is used	Tewari *et al*. (2017)
7	*Phyllanthus amarus* Schumach. & Thonn.	Gale of the wind, seed on the leaf	Keelanelli	Whole plant	The infusion of the whole plant is taken twice a day for 4 weeks	

WP: Whole plant, L: Leaves, R: Roots, T: Tubers, F: Fruits, B: Bark

CONCLUSION

The remarkable potency of medicinal herbs is utilized in the treatment of jaundice. Nevertheless, few studies have been conducted on the scientific validation of medicinal plants using ethnopharmacological approaches to validate the folklore medicine for jaundice healing across different traditional medicinal systems. In our review, we discussed 34 ethnopharmacological plant species from different families used in traditional medicinal systems to treat jaundice. Among the noted plant species, the most commonly used traditional plants for treating jaundice include E. ribes, H. helix, J. adhatoda, B. aristata, A. vera, and T. cordifolia.

Many researchers describe the efficacy and use of various medicinal plants in the treatment of jaundice. The tribal people of Chhattisgarh have used innumerable medicinal plants to get relief from jaundice and other liver-related disorders. Herbal remedies commonly used for treating jaundice among the tribal communities of Kerala state were reported (Abraham, 2025) . Although there is abundant ethnopharmacological information on plants used in jaundice treatment, only a few have been explored in clinical trials and studied for their mechanisms of action, highlighting the need for further research to improve the efficiency and relevance of jaundice treatment and to standardize clinical procedures.

Various newly synthesized entities have been developed that rely on natural products documented over the last few decades. Ethnopharmacological evidence is the primary basis for the use of therapeutically important molecules and their interventions. This comprehensive review showed the importance of medicinal plants in consort with several traditional medicine systems for combating jaundice. The current study provides insights into the traditional uses of various medicinal plants to develop innovative medications for treating jaundice.

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