

Traditional utilization and pharmacology of *Cinnamomum glanduliferum*: a review on current research status

Shaiphali SAXENA^{1*}, Pasumarti B. RAO²

¹Government Post Graduate College, Department of Botany, Manila- 263667, District Almora, Uttarakhand, India; shefalisaxena1192@gmail.com

²G.B. Pant University of Agriculture & Technology, Department of Biological Sciences, College of Basic Sciences & Humanities, Pantnagar- 263145, Uttarakhand, India; pasumartib658@gmail.com

Abstract

Cinnamomum glanduliferum (Wall.) Meisn from Lauraceae, commonly referred to as 'Nepal camphor tree' or 'false camphor tree', is mainly known for its spice qualities and aromaticity. The pleasant aroma mainly develops due to the presence of valuable phytoconstituents in the form of terpenes and volatile hydrocarbons conferring the plant species a camphor substitute. Bulk of studied researches on *C. glanduliferum* segregated and not well documented. This study however attempted to congregate the fragmented data based on the ethnomedicinal, pharmacological and biochemical properties along with the other miscellaneous data. Results authenticated sparse documentation on the ethnomedicinal, pharmacological and biochemical properties of *C. glanduliferum* thus pointed to the untapped information on the various potentials of the plant. Exploring its sustainable utilization, pharmacological, biochemical and nutraceutical potentials are recommended.

Keywords: biological and pharmacological activities; *C. glanduliferum*; ethnomedicinal properties; genome; patents; phytoconstituents; taxonomic classification

Introduction

The genus *Cinnamomum* is coming from 'kinnamomon' (Greek), which means both the 'sweet wood' and 'spice'. In 1760, this genus was mentioned, for the first time, by Schaeffer. There are about 250 to 300 species of this genus worldwide, 26 species from India, out of which 12 species are concentrated to the north-eastern parts of India (Ranasinghe *et al.*, 2012; Singh *et al.*, 2013; Kumar *et al.*, 2019). The leaves of the genus are extensively utilized for essential oil production and in the form of food spices as the leaves upon crushing emit spicy odour with good taste (Prasad *et al.*, 2009). Previously, several biochemical, pharmacological and ethnobotanical research studies have been accomplished on different species of the genus. Surprisingly, the research information on *Cinnamomum tamala* concerning its pharmaceutical and biochemical potential is inestimable. However, the research work done on *C. glanduliferum* is very sparse hitherto.

Received: 11 Feb 2022. Received in revised form: 04 Apr 2022. Accepted: 09 May 2022. Published online: 30 May 2022.

From Volume 13, Issue 1, 2021, Notulae Scientia Biologicae journal uses article numbers in place of the traditional method of continuous pagination through the volume. The journal will continue to appear quarterly, as before, with four annual numbers.

Cinnamomum glanduliferum (Wall.) Meisn is distributed in India (Assam, Tripura, Arunachal Pradesh, Meghalaya and Utrakahnd), Bhutan, China, Nepal, Malaysia, Tibet and Myanmar, and is considered to be the native of tropical Himalayan regions of India and Nepal (Figure 1). In India, the plant is found at an elevation of 1200-2500 m in both the plains and hills, and named as 'Gondsoroi tree'. All parts of the plant are aromatic due to the presence of essential oils enriched with cineole, nerolidol, borneol, pinene, terpeniol, camphor, etc. as major phytocompounds (Azab *et al.*, 2017; Zhao *et al.*, 2019; Geethakumary *et al.*, 2021). The plant wood possesses d-camphor, a good substitute of Sassafras, while the leaf essential oil having cineole emits camphor-like odour (Baruah and Nath, 2006). In the United States of America, the approximate market price for its oils falls under 10 to 20 USD per kilogram for the purpose of pesticides (Jiang *et al.*, 2012). The plant species having forest habitat is though kept under the 'least concern' category of IUCN Red Data Book in the year 2019 but it is continuously being declined in the occupancy areas (<https://iucnredlist.org/>; Liu and Liu, 2019; Geethakumary *et al.*, 2021).

Study purpose

The previous research information on the ethnomedicinal, biochemical and pharmacological properties *C. glanduliferum* is fragmented, scarce and not well-documented. This review was geared towards the compilation of the ethnomedicinal, pharmacological and biochemical properties of *C. glanduliferum* thus along with other miscellaneous information.

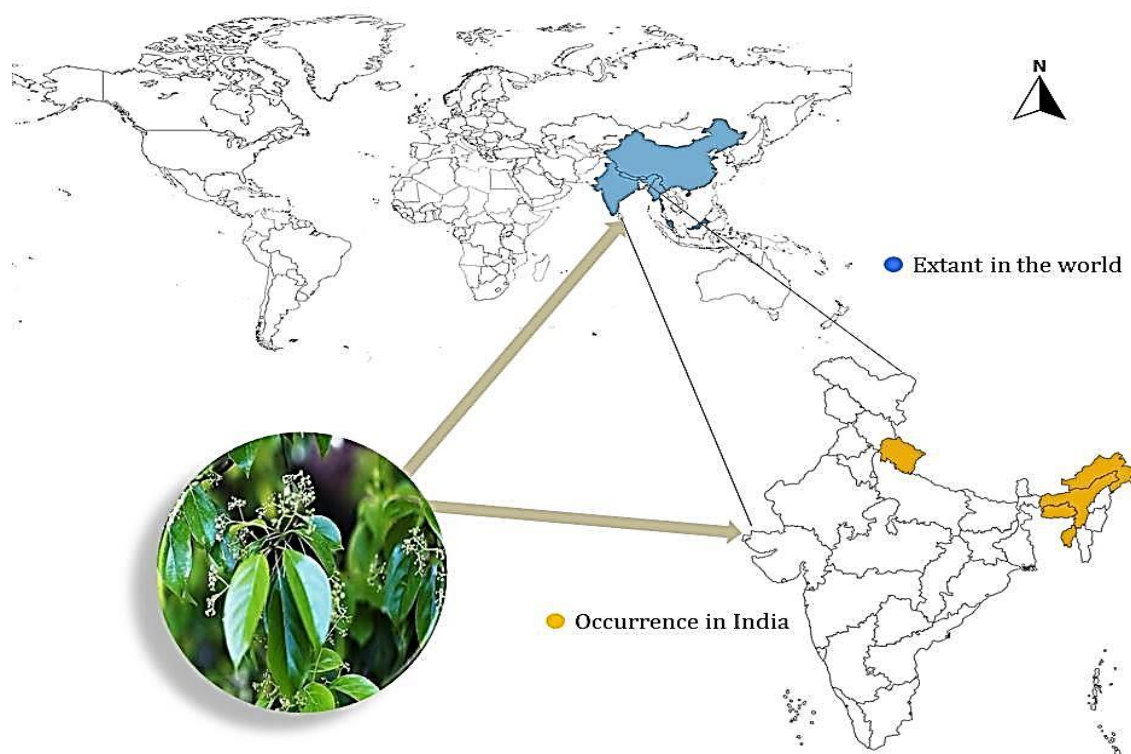


Figure 1. The map showing extant of *C. glanduliferum* in the world and occurrence in India

Strategy of Literature Search

The information for the present review was compiled by searching previous studies conducted on the reference plant species from December, 2021 to January, 2022 (Figure 2). The accessible primary and secondary research study sources of 31 years were searched and reviewed using Google Scholars (<http://scholar.google.com>),

Taylor and Francis (<https://tandfonline.com/>), Science Direct (<http://www.sciencedirect.com>), Wiley online library (<https://onlinelibrary.wiley.com/>), MDPI (<https://www.mdpi.com/>), PubMed (<https://pubmed.ncbi.nlm.nih.gov/>), NCBI (<https://www.ncbi.nlm.nih.gov/>), Google Patents (<https://patents.google.com/>), European Patents (<https://www.epo.org/>), United States Patent and Trademark Office (<https://www.uspto.gov/>) and Indian Patent Office (<https://ipindia.gov.in/advanced-search.htm?keysrch>) published from 1991 to 2022. The validation of plant species name was done by accessing The Plant List (2013). Searches were made using the following keywords- *Cinnamomum*, *C. glanduliferum*, taxonomic classification, medicinal properties, patents, phytoconstituents, biological and pharmacological activities. The research data about *C. glanduliferum* in English was limited and some work was inaccessible. Hence, for obtaining the additional research information on the plant species, manual search option was adopted by using cited references, websites and other sources of included papers. The searched data were included on the basis of the presence of reference plant species name and English language, while excluded due to the duplication and other languages. After that, the full titles and abstracts were read for further article screening and again the search studies were excluded due to the absence of the keywords and full text articles. Consequently, the remaining searches were selected and kept for the present review analysis.

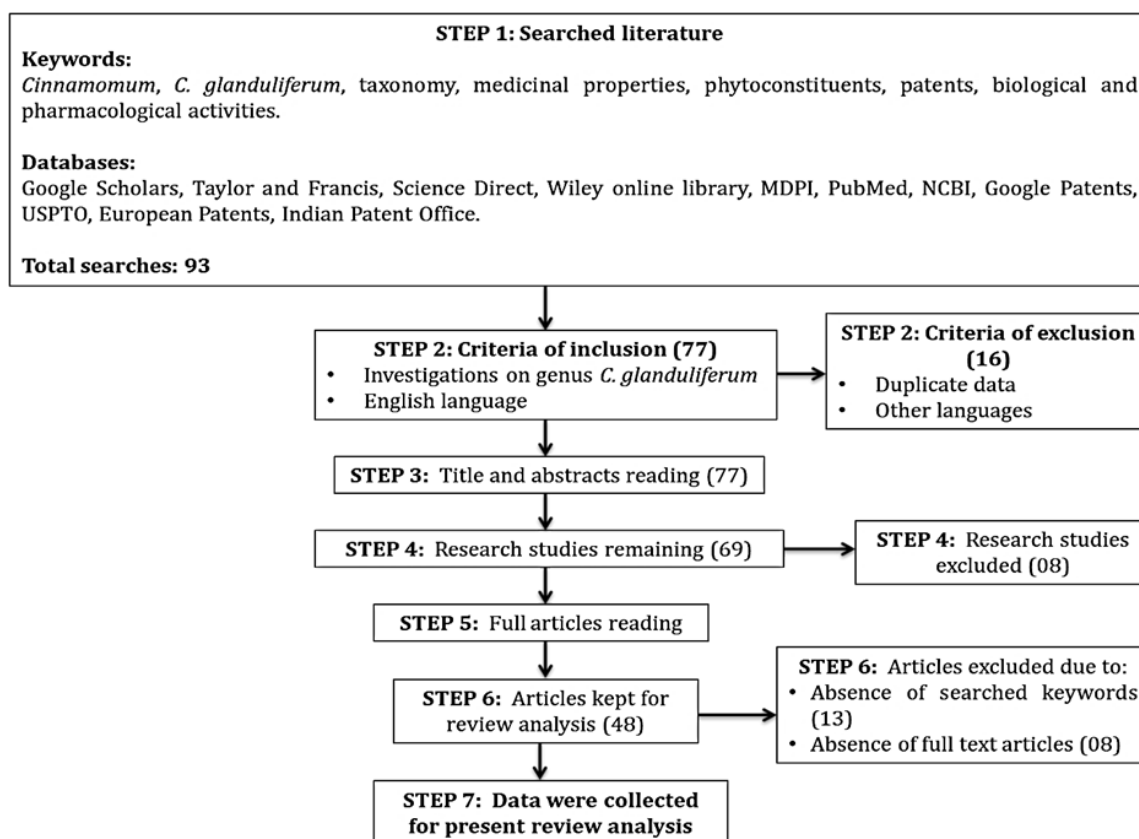


Figure 2. Strategy of searching the literature

Taxonomy and Botanical Description

Kingdom: Plantae
Clade: Tracheophytes
Clade: Angiosperms
Clade: Magnoliids
Order: Laurales

Family: Lauraceae
 Genus: *Cinnamomum*
 Species: *C. glanduliferum*

Cinnamomum glanduliferum (Wall.) Meisn. is an accepted name with five synonym namely *Camphora glandulifera* (Wall.) Nees, *Cinnamomum cavaleriei* H. Lév., *Machilus dominii* H. Lév., *Machilus mekongensis* Diels and *Laurus glandulifera* Wall. (also, a basionym) according to The Plant List and International Plant Name Index (The Plant List, 2013; IPNI, 2021). Subglabrous leaves are alternate with 1.5-3 cm petiole, elliptic to lanceolate (6-15 × 4-6.5 cm). Panicle (4-10 cm) is axillary with 2-4 cm glabrous peduncle and 1-2 mm short pedicels. Flowers (3mm) are small, fragrant, inconspicuous, yellowish with sparsely white 6-lobed perianth. First and second whorls of stamens have complanate filaments, ovate filament-sized introrse anthers with only 9 fertile stamens. Each stamen of the third whorl contains two cordate short-stalked glands near the base with oblong and extrorse anthers (1mm). Triangular staminodes are 3 including pubescent stalk (<1 mm). Ovary is ovoid (1.2 mm), glabrous with slender style (1.2 mm) and 3-lobed discoid stigma. Fruits are globose (1 cm diameter) and black drupes. Flowering occurs during March to May and fruiting in July to September (WFO, 2022).

Plastid Genome

Approximately 152715 bp (base pair) long chloroplastid genome of *C. glanduliferum* comprises a long single copy (LSC) of 937617 bp (70.60%), a small single copy (SSC) of 18870 bp (14.23%), and a pair of inverted repeats (IR) of 20114 bp (15.17%) with 39.1% G+C content (Figure 3). This plastome construction shows its phylogenetic relationship with *C. bodinieri* under the genus *Cinnamomum* (Zhao *et al.*, 2019).

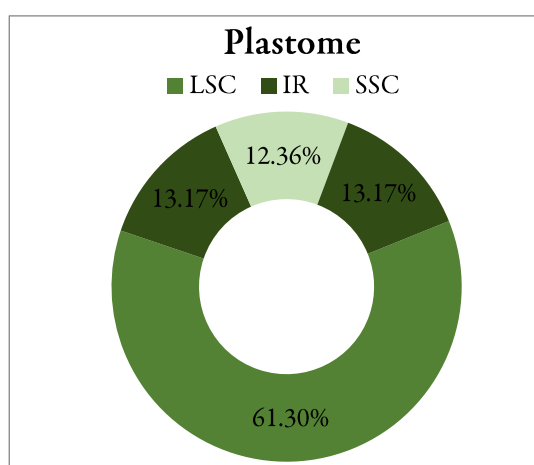


Figure 3. A hypothetical structure of plastid genome of *C. glanduliferum*

Plant as a Host

The host plants in the sericulture have crucial role for maintaining the quality and quantity of the silk produced. According to the previous studies, *C. glanduliferum* has been a great host for the polyphagous or non-mulberry silkworms (Tikader and Kamble, 2010). The plant has been reported to rear the larvae of *Antheraea assama* (muga silkworm of Assam) on its leaves. The rearing duration (29 days) and effective reproductive rate (60.00%) of larvae on the plant were significantly higher as compared to the other studied plant species namely *Machilus bombycina* (25 days and 57.40%) and *Litsaea polyantha* (25 days and 52.00%)

(Ram and Samson, 1991). The plant is also reported to rear *Samia ricini* (eri silkworm) as a tertiary host (Das *et al.*, 2020).

Ethnomedicinal and Traditional Uses

The Hill Miri and Tagin tribes of Arunachal Pradesh use *C. glanduliferum* bark with rice and *Solanum nigrum* leaves for preparing starter culture prepared within 7 to 10 days that can be stored up to 6 months (Shrivastava *et al.*, 2012). About 5mL of stem bark and leave juice is given thrice a day for treating cough in Mizoram (Sharma *et al.*, 2001). The roots of *C. glanduliferum* are used treat toothache, wounds and diabetes, while the leaves are used in the management of cough, cold as well as carminative, analgesic, astringent, antiseptic, anti-rheumatic and stimulant. The plant bark relieves kidney troubles and hook worm expulsion. The kernel fat of fruits is utilized for industrial purposes, while the seeds help in medicating toothache, cold, cough, taeniasis, body ache, joint pain, muscular swelling and spasm. Its timber is used for household purposes and furniture making such as cabinet, decoration and plywood manufacturing (Greeshma *et al.*, 2006; Shu *et al.*, 2008; Doley *et al.*, 2009; Joshi *et al.*, 2016; Kumar and Kumari, 2019). The decoction from crushed fruits of *C. glanduliferum* comprises the antipyretic and insect repellent qualities (Xiong *et al.*, 2020).

Pharmacological and Clinical Studies

Anti-inflammatory and Gastroprotective Activity

Azab *et al.* (2017) investigated the gastroprotective and anti-inflammatory activities of essential oil extracted from green branches and leaves of *C. glanduliferum* by ethanol-induced gastritis and carrageenan-induced Wistar rat paw-oedema methods, respectively. The volatile oil doses at 250, 500 and 1000 mg/kg concentrations significantly suppressed the gastritis by reducing the nitric oxide content (32, 37 and 41 μM nitrate/g) and lipid peroxidation inhibition (1.15, 1.11 and 1.04 nmol/g). The volatile oil from leaves with 4 hrs treatment on rat reduced the paw volume (93.75 ± 1.3 , 81.6 ± 3.3 and $69.14 \pm 1.9\%$) and oedema inhibition (39.8, 47.65 and 55.6%) at 250, 500 and 1000 mg/kg doses, respectively at significant level. Further, the anti-inflammatory inhibition was confirmed by inhibition of COX-2 activity (73.8, 50.7 and 21.4 nmol/min/mL) PGE2 concentration (2.95 ± 0.2 , 2.45 ± 0.15 and 1.75 ± 0.015 pg/mL) for the same concentrations.

Antimicrobial and anticancer potential

In cytotoxicity test *via* brine shrimp lethality assay, the LC_{50} ($\mu\text{g/mL}$) values for *C. glanduliferum* leaf and bark ethanol extracts were reported to be 87 and 110.3 (Maridass, 2008). Singh *et al.* (2013) assessed the antimicrobial activity of *C. glanduliferum* essential oil against ten foodborne microbial strains. The best minimum inhibitory concentration ($\mu\text{g/mL}$) was exhibited against *Aeromonas salmonicida* (1.72) > *Escherichia coli* and *Pseudomonas aeruginosa* (3.43) > *Micrococcus luteus* (6.86) > *Staphylococcus aureus* (11.66) and > *Erwinia herbicola* (13.73).

Mohamed *et al.* (2016) investigated the antibacterial activity of *C. glandulifera* leaf essential oil against six bacterial pathogens. The plant essential oil exhibited highest antibacterial potential than other studied plant species with minimum inhibitory concentration ($\mu\text{g/mL}$) as 0.49 (for *Staphylococcus aureus* and *Klebsiella pneumoniae*) > 0.98 (for *Streptococcus pneumoniae* and *Escherichia coli*) > 3.9 (for Methicillin-Resistant *Staphylococcus aureus*).

Taha and Eldahshan (2017) accessed the antimicrobial and anticancer potential of *C. glanduliferum* bark essential oil. The bark oil showed better minimum inhibitory concentration ($\mu\text{g/mL}$) against *Escherichia*

coli (0.49) < *Bacillus subtilis* (0.98) < *Geotricum candidum* (1.95) < methicillin-resistant *Staphylococcus aureus* (7.81) and = *Pseudomonas aeruginosa* (7.81), while maximum zone of inhibition (mm) against *Mycobacterium tuberculosis* (43.25 ± 1.5) > *Escherichia coli* (25.3 ± 1.0) and > *Bacillus subtilis* (22.4 ± 0.58). The anticancer potential of bark oil showed cytotoxicity IC_{50} ($\mu\text{g}/\text{mL}$) against HCT-116 (human colon carcinoma cell line) HepG2 (human hepatocellular carcinoma cell line) and MCF-7 (human breast carcinoma cell line) as 9.1, 42.4 and 57.3, respectively.

Insecticidal property

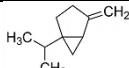
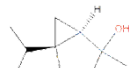

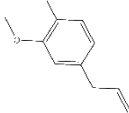
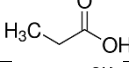
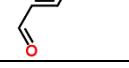
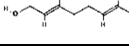
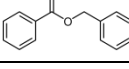
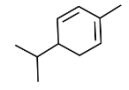
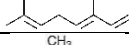
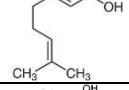
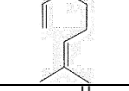


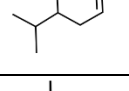
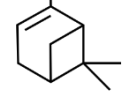
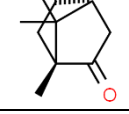
The insecticidal potential of *C. glanduliferum* essential oil against third instar *Trichoplusia ni* larvae (cabbage looper) was studied by Jiang *et al.* (2012). The mortality rate (%) for the topical application method at 200 $\mu\text{g}/\text{larva}$ was 80.8 ($LD_{50} = 76.0 \mu\text{g}/\text{larva}$) and for fumigation bioassay at 50 $\mu\text{L}/\text{L}$ was 100.0 ($LC_{50} = 29.7 \mu\text{L}/\text{L}$).

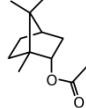
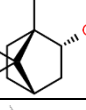

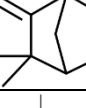
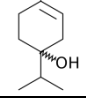
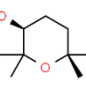
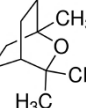
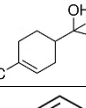
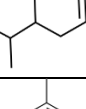
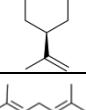
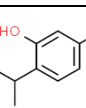
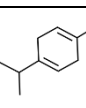
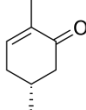
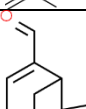
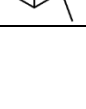

Phytochemistry

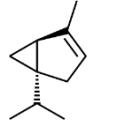
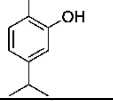
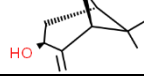
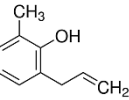
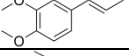
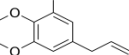
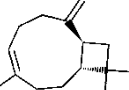
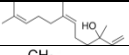
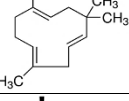
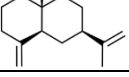
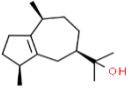
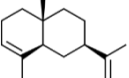
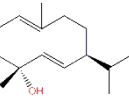
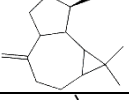
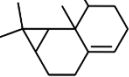
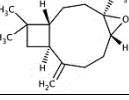
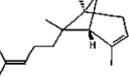
From our review, *C. glanduliferum* contains total of 76 different kinds of phytoconstituents belonging to various classes summarized in Table 1. Class wise, about 36.84% monoterpenes (19-46), 35.53% sesquiterpenes (50-76), 13.16% hydrocarbons (9-18), 5.26% alcohols (1-4), 3.95% aldehydes (5-7), 3.95% phenylpropenes (47-49), and 1.32% fatty acids (8) are present; while about 70.48% leaf, 13.33% stem, and 16.19% bark have been used for the essential oil extraction to characterize its phytoconstituents.

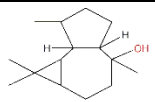
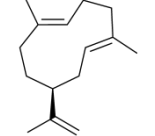
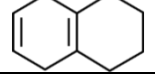
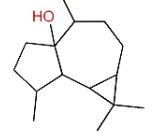
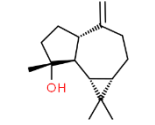
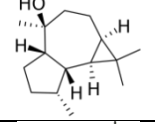
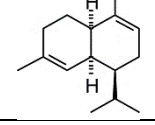
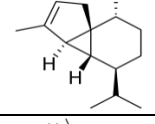
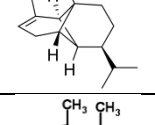
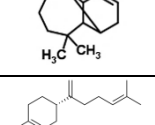
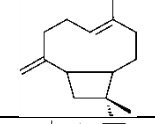
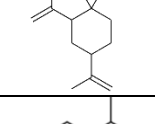
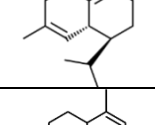
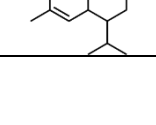

Table 1. List of phytoconstituents reported in *C. glanduliferum*

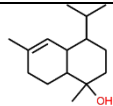
S. No.	Compound	Part Used	M.F.	M.W.	Structure
Alcohols					
1	2-propen-1-ol	L	C ₃ H ₆ O	58.08	
2	2-methyl-3-buten-2-ol	L	C ₅ H ₁₀ O	86.13	
3	2-methyl-2-propenal	L	C ₄ H ₆ O	70.09	
4	3-methyl-1-penten-3-ol	L	C ₆ H ₁₂ O	100.16	
Aldehydes					
5	Dodecanal	L	C ₁₂ H ₂₄ O	184.32	
6	Cinnamic aldehyde	L	C ₉ H ₈ O	132.16	
7	Tetradecanal	L	C ₁₄ H ₂₈ O	212.37	
Fatty acids					
8	Linoleic acid	L	C ₁₈ H ₃₂ O ₂	280.4	
Hydrocarbons					
9	(E)-Phytol acetate	L, S	C ₂₂ H ₄₂ O ₂	338.6	
10	Cyclohexene	L	C ₆ H ₁₀	82.14	

11	Sabinene	L, S, B	C ₁₀ H ₁₆	136.23	
12	<i>trans</i> -sabinenhydrat	L	C ₁₀ H ₁₈ O	154.25	
13	<i>cis</i> -sabinenhydrat	L	C ₁₀ H ₁₈ O	154.25	
14	Eugenol	L	C ₁₀ H ₁₂ O ₂	164.2	
15	Propanoic acid	L	C ₃ H ₆ O ₂	74.08	
16	(E)-2-pentenal	L	C ₅ H ₈ O	84.12	
17	2,6-octadien1-ol	L	C ₈ H ₁₄ O	126.2	
18	Benzyl benzoate	L	C ₁₄ H ₁₂ O ₂	212.25	
Monoterpenes					
19	p-cymene	L, S, B	C ₁₀ H ₁₆	136.24	
20	(E)-β-ocimene	L	C ₁₀ H ₁₆	136.24	
21	Geraniol	L	C ₁₀ H ₁₈ O	170.25	
22	Linalool	L	C ₁₀ H ₁₈ O	170.25	
23	β-pinene	L, S, B	C ₁₀ H ₁₆	136.24	
24	β-myrcene	L, S, B	C ₁₀ H ₁₆	136.24	
25	α-terpinene	L, S, B	C ₁₀ H ₁₆	136.24	
26	α-pinene	L, S, B	C ₁₀ H ₁₆	136.24	
27	Camphor	B	C ₁₀ H ₁₆ O	152.23	

28	(-)-bornyl acetate	L	C ₁₂ H ₂₀ O ₂	196.29	
29	Borneol	L, B	C ₁₀ H ₁₈ O	170.25	
30	<i>cis</i> -linalool oxide	L	C ₁₀ H ₁₈ O	170.25	
31	Terpinolene	L, S, B	C ₁₀ H ₁₆	136	
32	Camphene	L, S, B	C ₁₀ H ₁₆	136.24	
33	Terpinen-4-ol	L, S, B	C ₁₀ H ₁₈ O	154.25	
34	<i>trans</i> -linalool oxide	L	C ₁₀ H ₁₈ O ₂	170.25	
35	1,8-Cineole	L	C ₁₀ H ₁₈ O	154.25	
36	α -terpineol	L, S, B	C ₁₀ H ₁₈ O	154.25	
37	α -phellandrene	L, B	C ₁₀ H ₁₆	136.23	
38	Limonene	L, S, B	C ₁₀ H ₁₆	136.23	
39	<i>trans</i> -ocimene	L	C ₁₀ H ₁₆	136.23	
40	Thymol	L	C ₁₀ H ₁₄ O	150.22	
41	γ -terpinene	L	C ₁₀ H ₁₆	136.23	
42	Carvone	L	C ₁₀ H ₁₄ O	150.22	
43	Myrtenal	L	C ₁₀ H ₁₄ O	150.22	

44	α -thujene	L, S, B	C ₁₀ H ₁₆	136.23	
45	Carvacrol	L	C ₁₀ H ₁₄ O	236.8	
46	<i>cis</i> -pinocarveol	L	C ₁₀ H ₁₆ O	152.23	
Phenylproenes					
47	3-allyl-6-methoxyphenol	L	C ₁₀ H ₁₂ O ₂	164.2	
48	Methyl isoeugenol	L	C ₁₁ H ₁₄ O ₂	178.23	
49	Elemicin	L	C ₁₂ H ₁₆ O ₃	208.25	
Sesquiterpenes					
50	(E)-caryophyllene	L	C ₁₅ H ₂₄	204.35	
51	(E)-nerolidol	L	C ₁₅ H ₂₆ O	222.37	
52	α -humulene	L, S, B	C ₁₅ H ₂₄	204.35	
53	β -selinene	L	C ₁₅ H ₂₄	204.35	
54	Guaiol	B	C ₁₅ H ₂₆ O	222.37	
55	α -selinene	L	C ₁₅ H ₂₄	204.35	
56	Germacrene D-4-ol	L	C ₁₅ H ₂₆ O	222.37	
57	Alloaromadendrene	L	C ₁₅ H ₂₄	204.35	
58	Calarene	L	C ₁₅ H ₂₄	204.35	
59	Caryophyllene oxide	L	C ₁₅ H ₂₄ O	220.35	
60	<i>cis</i> - α -bergamotene	L	C ₁₅ H ₂₄	204.35	

61	Epiglobulol	L	C ₁₅ H ₂₆ O	222.37	
62	Germacrene-D	L	C ₁₅ H ₂₄	204.35	
63	Naphthalene,1,2,3,4,4a,7-hexahydro	L	C ₁₀ H ₁₄	134.22	
64	Palustrol	L	C ₁₅ H ₂₆ O	222.37	
65	Spathulenol	L	C ₁₅ H ₂₄ O	220.35	
66	Viridiflorol	L	C ₁₅ H ₂₆ O	222.37	
67	α -amorphene	L	C ₁₅ H ₂₄	204.35	
68	α -cubebene	L	C ₁₅ H ₂₄	204.35	
69	α -copaene	L	C ₁₅ H ₂₄	204.35	
70	α -longipinene	L	C ₁₅ H ₂₄	204.35	
71	β -bisabolene	L	C ₁₅ H ₂₄	204.35	
72	β -caryophyllene	L	C ₁₅ H ₂₄	204.35	
73	β -elemene	L	C ₁₅ H ₂₄	204.35	
74	d-cadinene	L	C ₁₅ H ₂₄	204.35	
75	α -muurolene	L	C ₁₅ H ₂₄	204.35	

76	α -cadinol	L	C ₁₅ H ₂₆ O	222.37	
----	-------------------	---	-----------------------------------	--------	---

Note: Part used: L= leaf, S= stem, B= bark; M.F.= molecular formula; M.W.= molecular weight.

Source: Baruah and Nath, 2006; Li *et al.*, 2013; Singh *et al.*, 2014; Jiang *et al.*, 2016; Taha and Eldahshan, 2017; Kumar *et al.*, 2019

Patents Filed

The patents help in conserving the innovative research works done by the inventors or applicants so that they can have proper rights to protect their inventions, knowledge and novel researches by excluding other people to exploit them (Saxena, 2020). The following patent text (containing title, application number, inventor, publication date and reference) is clearly indicating that all the patents applications filed on *C. glanduliferum* belong to the field of medicines and pharmacology. Moreover, these patents reports are very recent (from 2011 to 2017) and have Chinese origin. All the patent applications filed till now are mentioned hereunder.

- Title:** *Cinnamomum glanduliferum* seed oil-containing lotion capable of moisturizing and caring skin and preparation method thereof.
Application number: CN104434636A
Inventor: Quing, 2015a
Publication date: 25-03-2015
Reference: <https://patents.google.com/patent/CN104434636A/en>
- Title:** Natural moisturizing cream containing Yunnan camphor tree seed oil.
Application number: CN104323955A
Inventor: Quing, 2015b
Publication date: 04-02-2015
Reference: <https://patents.google.com/patent/CN104323955A/en>
- Title:** Tibetan incense and preparation method thereof.
Application number: CN104800878A
Inventor: Zhaxiwangmu and Luobu, 2015
Publication date: 29-07-2015
Reference: <https://worldwide.espacenet.com/patent/search/family/053686352/publication/CN104800878A?q=cinnamomum%20glanduliferum>
- Title:** Purely-natural facial cleanser capable of deeply decontaminating and controlling oil and preparation method thereof.
Application number: CN104434639A
Inventor: Quing, 2015c
Publication date: 25-03-2015
Reference: <https://worldwide.espacenet.com/patent/search/family/052881907/publication/CN104434636A?q=cinnamomum%20glanduliferum>
- Title:** Traditional Chinese medicine composition for treating wind-cold tightening superficialities type cold.
Application number: CN104984125A
Inventor: Huaying, 2015
Publication date: 21-10-2015
Reference: <https://worldwide.espacenet.com/patent/search/family/054296108/publication/CN104984125A?q=cinnamomum%20glanduliferum>

6. **Title:** Healthcare tea and making method thereof.
Application number: CN105148150A
Inventor: Shaozhong, 2015
Publication date: 16-12-2015
Reference:<https://worldwide.espacenet.com/patent/search/family/054789411/publication/CN105148150A?q=cinnamomum%20glanduliferum>
7. **Title:** Saffron crocus dissolved medicine and preparation method thereof.
Application number: CN102078479A
Inventor: Zhang, 2011
Publication date: 01-06-2011
Reference:<https://worldwide.espacenet.com/patent/search/family/044084803/publication/CN102078479A?q=cinnamomum%20glanduliferum>
8. **Title:** Pre-operation anesthetic and preparation method thereof.
Application number: CN105853519A
Inventor: Li and Haiqing, 2016
Publication date: 17-08-2016
Reference:<https://worldwide.espacenet.com/patent/search/family/056649903/publication/CN105853519A?q=cinnamomum%20glanduliferum>
9. **Title:** Traditional Chinese medicine preparation for treating heat exhaustion and preparation method thereof.
Application number: CN105920140A
Inventor: Fengsheng, 2016
Publication date: 07-09-2016
Reference:<https://worldwide.espacenet.com/patent/search/family/056828957/publication/CN105920140A?q=cinnamomum%20glanduliferum>
10. **Title:** Traditional Chinese medicine composition for treating wind-cold-damp type entrapment syndrome of superior clunial nerves.
Application number: CN106955310A
Inventor: Xia, 2017
Publication date: 18-07-2017
Reference:<https://worldwide.espacenet.com/patent/search/family/059480725/publication/CN106955310A?q=cinnamomum%20glanduliferum>
11. **Title:** Traditional Chinese medicine preparation for treating children bronchial asthma and preparation method thereof.
Application number: CN105288200A
Inventor: Linben and Xiaofei, 2016
Publication date: 03-02-2016
Reference:<https://worldwide.espacenet.com/patent/search/family/055186478/publication/CN105288200A?q=cinnamomum%20glanduliferum>
12. **Title:** Traditional Chinese medicine preparation for treating shoulder joint instability and preparation method.
Application number: CN105796721A
Inventor: Zebing and Bingxiu, 2016
Publication date: 27-07-2016
Reference:<https://worldwide.espacenet.com/patent/search/family/056455932/publication/CN105796721A?q=cinnamomum%20glanduliferum>
13. **Title:** Medicine used for treating infantile hip joint dysplasia and preparation method thereof.

Application number: CN105031282A

Inventor: Yiming, 2015

Publication date: 11-11-2015

Reference: <https://worldwide.espacenet.com/patent/search/family/054438642/publication/CN105031282A?q=cinnamomum%20glanduliferum>

14. Title: Traditional Chinese medicine preparation for treating pediatric abdominal distension and preparation method thereof.

Application number: CN105664025A

Inventor: Lizhi, 2016

Publication date: 15-06-2016

Reference: <https://worldwide.espacenet.com/patent/search/family/056304450/publication/CN105664025A?q=cinnamomum%20glanduliferum>

15. Title: Oral-administration medicine treating anal cryptitis.

Application number: CN105267796A

Inventor: Fukui and Chunli, 2016

Publication date: 27-01-2016

Reference: <https://worldwide.espacenet.com/patent/search/family/055138185/publication/CN105267796A?q=cinnamomum%20glanduliferum>

Discussion

Astonishingly, a very few research studies have been conducted on the genomic, biochemical, ethnobotanical and pharmaceutical properties of *C. glanduliferum*, leading to the scarce and fragmented research status of the reference plant species despite of 31 years of researching on same plant according to this review. Furthermore, our review showed that most of the researches on *C. glanduliferum* were mostly focused on patents (34.88%), ethnomedicines (18.60%), phytoconstituent characterization (13.95%), geographical distribution (9.30%), antimicrobial studies (6.98%), sericultural practices (6.98%), cytotoxicity (4.65%), insecticidal activity (2.33%) and anti-inflammatory potential (2.33%). Most of the researches done on *C. glanduliferum* till date have been conducted among the years of 2011 to 2020 (Figure 4). *C. glanduliferum* can be one of the best host plants in the sericulture sectors in India for maintaining the quality and productivity of different types of silks. This quality may be due to the presence of valuable phytochemicals present in its leaves supporting the reproductive rate of the silkworms. Among the reported phytoconstituents of *C. glanduliferum*, monoterpenes and sesquiterpenes are maximum. Noticeably, the patent applications filed on *C. glanduliferum* are more in number as compared to their biological and pharmacological research studies. Moreover, all the patents, according to the present review research, are owned by China. This can be due to the wild occurrence and availability of the plant species in China. Another possible reason of more Chinese patents may be the consequence of maximum attention paid on researches and related activities in the fields of medicines than other nations (Indian subcontinents) where the plant species is distributed. Now *C. glanduliferum* has also been introduced into the northeast Argentina according to the information searched on The Plants of the World Online (POWO, 2022).

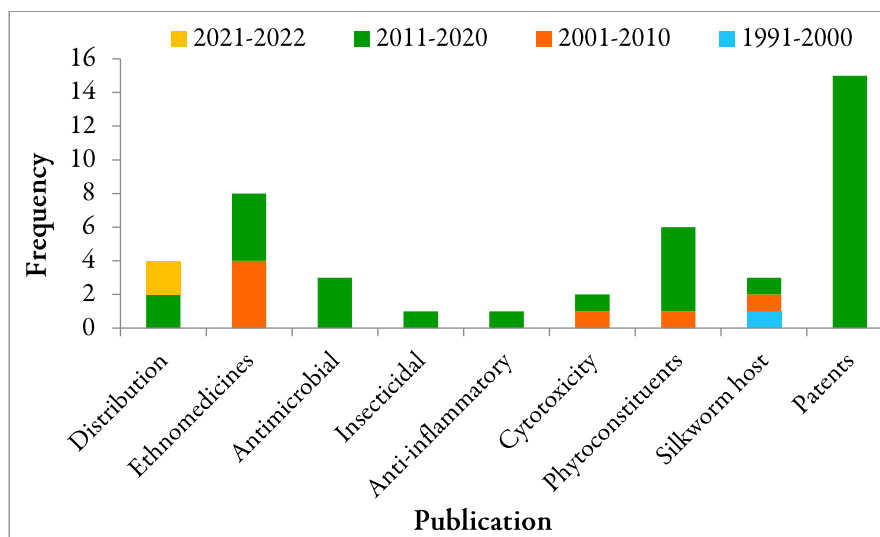


Figure 4. Year wise publications till date on *Cinnamomum glanduliferum*

Conclusions

The aromatic and medicinal plant species are largely viewed as valuable remedial sources. The present review on *C. glanduliferum* highlights its distribution, taxonomy, phylogeny, ethnobotanical, phytochemical and pharmacological aspects. The pharmacological activities conducted on *C. glanduliferum* show very recent findings (2008 to 2017), which need further attention to be studied by the future researchers. Although, the IUCN Red Data Book categorized the plant species as 'least concern' in the year 2019, but plant is facing the uninterrupted threats of being dwindled in its natural areas apparently due to the lack of adaptation ability of the plant, less genetic diversity, improper conservation and management strategies, and manual picking of its bark for spices and medicinal purposes. This action will surely lead the plant species towards vulnerability. So, the proper distribution strategies and deliberate introduction of the plant species are urgent appeal for sustaining its long-term survival.

Authors' Contributions

Both authors read and approved the final manuscript.

Ethical approval (for researches involving animals or humans)

Not applicable.

Acknowledgements

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. The authors are highly indebted to the researchers and scientists whose research findings and reviews are covered in the present review study to compile the taxonomical, traditional, ethnomedicinal and clinical medicinal knowledge on the reference plant species.

Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

References

- Azab SS, Abdel Jaleel GA, Eldahshan OA (2017). Anti-inflammatory and gastroprotective potential of leaf essential oil of *Cinnamomum glanduliferum* in ethanol-induced rat experimental gastritis. *Pharmaceutical Biology* 55(1):1654-1661. <https://doi.org/10.1080/13880209.2017.1314512>
- Baruah A, Nath SC (2006). Leaf essential oils of *Cinnamomum glanduliferum* (Wall) Meissn and *Cinnamomum glaucescens* (Nees) Meissn. *Journal of Essential Oil Research* 18(2):200-202. <https://doi.org/10.1080/10412905.2006.9699065>
- Das SK, Sahu BK, Singh D (2020). Host plant diversity of non-mulberry silkworms: a review. *Journal of Pharmacognosy and Phytochemistry* 9(3):109-113.
- Doley B, Gajurel PR, Rethy P, Singh B, Hazarika H (2009). Ethnomedicinal uses of different species of *Cinnamomum* Schaeffer (Lauraceae) by ethnic communities in Arunachal Pradesh, India. *Pleione* 3(1):9-12.
- Fengsheng S (2016). Traditional Chinese medicine preparation for treating heat exhaustion and preparation method thereof (European Patent No. CN105920140A). European Patent Office. Retrieved 2022 January 20 from: <https://worldwide.espacenet.com/patent/search/family/056828957/publication/CN105920140A?q=cinnamomum%20glanduliferum>
- Fukui G, Chunli Z (2016). Oral-administration medicine treating anal cryptitis (European Patent No. CN105267796A). European Patent Office. Retrieved 2022 January 21 from: <https://worldwide.espacenet.com/patent/search/family/055138185/publication/CN105267796A?q=cinnamomum%20glanduliferum>
- Geethakumary MP, Deepu S, Pandurangan AG (2021). Synopsis of the genus *Cinnamomum* Schaeffer (Lauraceae) in India. *Plant Science Today* 8(1):199-209. <http://dx.doi.org/10.14719/pst.2021.8.1.1028>
- Greeshma AG, Srivastava B, Srivastava K (2006). Plants used as antimicrobials in the preparation of traditional starter cultures of fermentation by certain tribes of Arunachal Pradesh. *Bull Arunachal Forest Research* 22(1&2):52-57. Retrieved 2021 December 27 from: <https://www.iucnredlist.org/species/147648804/147648806#assessment-information>
- IPNI (2021). Retrieved 2021 December 25 from: <https://www.ipni.org/n/463435-1>.
- Jiang H, Wang J, Song L, Cao X, Yao X, Tang F, Yue Y (2016). GC× GC-TOFMS analysis of essential oils composition from leaves, twigs and seeds of *Cinnamomum camphora* L. Presl and their insecticidal and repellent activities. *Molecules* 21(4):423. <https://doi.org/10.3390/molecules21040423>
- Jiang ZL, Akhtar Y, Zhang X, Bradbury R, Isman MB (2012). Insecticidal and feeding deterrent activities of essential oils in the cabbage looper, *Trichoplusia ni* (Lepidoptera: Noctuidae). *Journal of Applied Entomology* 136(3):191-202. <https://doi.org/10.1111/j.1439-0418.2010.01587.x>
- Joshi RK, Satyal P, Setzer WN (2016). Himalayan aromatic medicinal plants: a review of their ethnopharmacology, volatile phytochemistry, and biological activities. *Medicines* 3(1):6. <https://dx.doi.org/10.3390%2Fmedicines3010006>
- Kumar S, Kumari R (2019). *Cinnamomum*: review article of essential oil compounds, ethnobotany, antifungal and antibacterial effects. *Open Access Journal of Science* 3:13-16. <https://doi.org/10.15406/oajs.2019.03.00121>
- Kumar S, Kumari R, Mishra S (2019). Pharmacological properties and their medicinal uses of *Cinnamomum*: a review. *Journal of Pharmacy and Pharmacology* 71:1735-1761. <https://doi.org/10.1111/jphbp.13173>
- Li YQ, Kong DX, Wu H (2013). Analysis and evaluation of essential oil components of cinnamon barks using GC-MS and FTIR spectroscopy. *Industrial Crops and Products* 41:269-278. <https://doi.org/10.1016/j.indcrop.2012.04.056>

- Linben G, Xiaofei Y (2016). Traditional Chinese medicine preparation for treating children bronchial asthma and preparation method thereof (European Patent No. CN105288200A). European Patent Office. Retrieved 2022 January 20 from: <https://worldwide.espacenet.com/patent/search/family/055186478/publication/CN105288200A?q=cinnamomum%20glanduliferum>
- Liu B, Liu H (2019). Botanic Gardens Conservation International (BGCI) & IUCN SSC Global Tree Specialist Group. *Cinnamomum glanduliferum*. The IUCN Red List of Threatened Species. Retrieved 2022 January 04 from: <https://dx.doi.org/10.2305/IUCN.UK.2019-2.RLTS.T147648804A147648806.en>
- Lizhi H (2016). Traditional Chinese medicine preparation for treating pediatric abdominal distension and preparation method thereof (European Patent No. CN105664025A). European Patent Office. Retrieved 2022 January 20 from: <https://worldwide.espacenet.com/patent/search/family/056304450/publication/CN105664025A?q=cinnamomum%20glanduliferum>
- Maridass M (2008). Evaluation of brine shrimp lethality of *Cinnamomum* species. *Ethnobotanical Leaflets* 12(1):772-775.
- Mohamed AS, Ahmed W, Elshatoury E, Mourad M (2016). Leaf Anatomy, chemical composition as well as essential oils and their antibacterial activity of some Lauraceous taxa. *Taekholmia* 36(1):77-101. <http://dx.doi.org/10.21608/taec.2016.11943>
- POWO (2022). Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Retrieved 2022 January 10 from: <https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:463435-1#source-KBD>
- Prasad KN, Yang B, Dong X, Jiang G, Zhang H, Xie H, Jiang Y (2009). Flavonoid contents and antioxidant activities from *Cinnamomum* species. *Innovative Food Science & Emerging Technologies* 10(4):627-632. <https://doi.org/10.1016/j.ifset.2009.05.009>
- Quing L (2015a). *Cinnamomum glanduliferum* seed oil-containing lotion capable of moisturizing and caring skin and preparation method thereof (European Patent No. CN104434636A). European Patent Office. Retrieved 2022 January 20 from: <https://patents.google.com/patent/CN104434636A/en>
- Quing L (2015b). Natural moisturizing cream containing Yunnan camphor tree seed oil (European Patent No. CN104323955A). European Patent Office. Retrieved 2022 January 20 from: <https://patents.google.com/patent/CN104323955A/en>
- Quing L (2015c). Purely natural facial cleanser capable of deeply decontaminating and controlling oil and preparation method thereof (European patent No. CN104434639A). European Patent Office. Retrieved 2022 January 20 from: <https://worldwide.espacenet.com/patent/search/family/052881910/publication/CN104434639A?q=CN104434639A>
- Ram R, Samson MV (1991). *Cinnamomum glanduliferum* Meissn as an additional primary host plant for *Antheraea assama* Ww. *Indian Journal of Sericulture* 30(1):68-69.
- Ranasinghe P, Jayawardana R, Galappaththy P, Constantine GR, de Vas Gunawardana N, Katulanda P (2012). Efficacy and safety of 'true' cinnamon (*Cinnamomum zeylanicum*) as a pharmaceutical agent in diabetes: a systematic review and meta-analysis. *Diabetic Medicine* 29(12):1480-1492. <https://doi.org/10.1111/j.1464-5491.2012.03718.x>
- Saxena S (2020). The current research status of endangered *Rhynchosstylis retusa* (L.) Blume: a review. *Asian Journal of Research in Botany* 4(2):16-25.
- Shaozhong S (2015). Healthcare tea and making method thereof (European Patent No. CN105148150A). European Patent Office. Retrieved 2022 January 20 from: <https://worldwide.espacenet.com/patent/search/family/054789411/publication/CN105148150A?q=cinnamomum%20glanduliferum>
- Sharma HK, Chhange L, Dolui AK (2001). Traditional medicinal plants in Mizoram, India. *Fitoterapia* 72(2):146-161. [https://doi.org/10.1016/S0367-326X\(00\)00278-1](https://doi.org/10.1016/S0367-326X(00)00278-1)

- Shrivastava K, Greeshma AG, Srivastava B (2012). Biotechnology in Tradition-Methods of starter preparation for alcoholic beverages employed by different tribal communities of Arunachal Pradesh. *Indian Journal of Traditional Knowledge* 11(1):194-201.
- Shu Z, Xiwen L, Jie L, Van der Werff H (2008). *Cinnamomum* Schaeffer, Bot. Exped. 74. 1760, nom. cons. *Flora of China* 7:166-187.
- Singh C, Singh S, Pande C, Tewari G, Kharkwal GC (2014). Chemical composition of the leaves essential oil from *Cinnamomum glanduliferum* (Wall) Meissn from Uttarakhand, India. *Journal of Essential Oil Bearing Plants* 17(5):927-930.
- Singh C, Singh S, Pande C, Tewari G, Pande V, Sharma P (2013). Exploration of antimicrobial potential of essential oils of *Cinnamomum glanduliferum*, *Feronia elephantum*, *Bupleurum hamiltonii* and *Cyclospermum leptophyllum* against foodborne pathogens. *Pharmaceutical Biology* 51(12):1607-1610. <https://doi.org/10.3109/13880209.2013.805234>
- Taha AM, Eldahshan OA (2017). Chemical characteristics, antimicrobial, and cytotoxic activities of the essential oil of Egyptian *Cinnamomum glanduliferum* bark. *Chemistry & Biodiversity* 14(5):c1600443. <https://doi.org/10.1002/cbdv.201600443>
- The Plant List (2013). Retrieved 2021 December 25 from: <http://www.theplantlist.org/tpl1.1/search?q=Cinnamomum+glanduliferum>
- Tikader A, Kamble C (2010). Seri-biodiversity with reference to host plants in India. *The Asian and Australian Journal of Plant Science and Biotechnology* 4(1):1-11.
- WFO (2022). *Cinnamomum glanduliferum* (Wall.) Meisn. Retrieved 2022 February 01 from: <http://www.worldfloraonline.org/taxon/wfo-0000605088>
- Xia C (2017). Traditional Chinese medicine composition for treating wind-cold-damp type entrapment syndrome of superior clunial nerves (European Patent No. CN106955310A). European Patent Office. Retrieved 2022 January 21 from: <https://worldwide.espacenet.com/patent/search/family/059480725/publication/CN106955310A?q=cinnamomum%20glanduliferum>
- Xiong Y, Sui X, Ahmed S, Wang Z, Long C (2020). Ethnobotany and diversity of medicinal plants used by the Buyi in eastern Yunnan, China. *Plant Diversity* 42:401-414. <https://doi.org/10.1016/j.pld.2020.09.004>
- Yiming W (2015). Medicine used for treating infantile hip joint dropsy and preparation method thereof (European Patent No. CN105031282A). European Patent Office. Retrieved 2022 January 21 from: <https://worldwide.espacenet.com/patent/search/family/054438642/publication/CN105031282A?q=cinnamomum%20glanduliferum>
- Zebing L, Bingxiu W (2016). Traditional Chinese medicine preparation for treating shoulder joint instability and preparation method thereof (European Patent No. CN105796721A). European Patent Office. Retrieved 2022 January 20 from: <https://worldwide.espacenet.com/patent/search/family/056455932/publication/CN105796721A?q=cinnamomum%20glanduliferum>
- Zhang F (2011). Saffron crocus dissolved medicine and preparation method thereof (European Patent No. CN102078479A). European Patent Office. Retrieved 2022 January 21 from: <https://worldwide.espacenet.com/patent/search/family/044084803/publication/CN102078479A?q=cinnamomum%20glanduliferum>
- Zhao G, Yang J, Wang X, Song Y, Zhu R (2019). The plastid genome of a spice plants *Cinnamomum glanduliferum* in Tibet (Lauraceae). *Mitochondrial DNA Part B* 4(2):3284-3285. <https://doi.org/10.1080/23802359.2019.1671249>
- Zhaxiwangmu, Luobu (2015). Tibetan incense and preparation method thereof (European Patent No. CN104800878A). European Patent Office. Retrieved 2022 January 20 from: <https://worldwide.espacenet.com/patent/search/family/053686352/publication/CN104800878A?q=cinnamomum%20glanduliferum>



The journal offers free, immediate, and unrestricted access to peer-reviewed research and scholarly work. Users are allowed to read, download, copy, distribute, print, search, or link to the full texts of the articles, or use them for any other lawful purpose, without asking prior permission from the publisher or the author.



License - Articles published in *Notulae Scientia Biologicae* are Open-Access, distributed under the terms and conditions of the Creative Commons Attribution (CC BY 4.0) License.

© Articles by the authors; SHST, Cluj-Napoca, Romania. The journal allows the author(s) to hold the copyright/to retain publishing rights without restriction.