# Bioactive Potential, Essential Oil Analysis of *Inula Cappa* Collected from Uttarakhand Himalaya, India

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**DOI: https://doi.org/10.51584/IJRIAS.2026.11010027**

**Received: 03 January 2026; Accepted: 15 January 2026; Published: 28 January 2026**

## ABSTRACT

*Inula cappa* (Buch.-Ham. ex D. Don) DC. (Asteraceae), a high potential medicinal herb and traditionally used in Ayurvedic, Chinese and Tibetan medicine, has been recognized for its diverse pharmacological properties. The present study aimed to evaluate the antioxidant potential and antimicrobial effect of leaf extracts obtained using different solvents. Antioxidant activity was assessed through standard assays, including DPPH radical scavenging, revealing a concentration-dependent free radical scavenging effect. The methanolic extract exhibited the highest antioxidant potential, correlating positively with its total phenolic and flavonoid content. Bioactive compounds were identified by GCMS. Antimicrobial activity was tested minimum inhibitory concentration (MIC) methods. Results demonstrated notable inhibition zones, particularly against *Staphylococcus aureus* and *Escherichia coli*, with the methanolic extracts showing superior efficacy compared to other extracts. These findings suggest that *Inula cappa* leaves are a promising source of natural antioxidants and antimicrobial agents, supporting their potential application in pharmaceutical formulations.

**Keywords:** *Inula cappa;* antioxidant capacity; antimicrobial effects; leaves extracts, Uttarakhand Himalaya

## INTRODUCTION

*Inula cappa* (Buch.-Ham. ex D. Don) DC. is a member of the Asteraceae family whose dried whole herb or root is used as a traditional Chinese medicine. It is also called BaiNiudan, DaLiwang, or YeXiabai [1]. *I. cappa* is distributed in Guizhou, Yunnan, Guangxi, and Hunan Province in China. As a commonly used medicine in the Miao region of Guizhou Province, *I. cappa* has the function of dispersing wind-heat, detumescence, and detoxification. It is used for the treatment of cold and fever, swelling and pain of the throat, rheumatism arthralgia pain, ulcerative carbuncle, and furunculosis, among others. Among the Dai people, *I. cappa* also known as "Nahan" is the main medicine of the famous Dai medical prescription "Ya Hutton San", which is included in the 2020 edition of the Chinese Pharmacopoeia. *I. cappa* has the effect of clearing away heat and toxic materials, analgesia, and hemostasis, and it is used in the treatment of cold and fever, pharyngitis, thoracoabdominal pain, palpitation, deficiency, irregular menstruation, and postpartum bleeding [2].

*I. cappa* is mainly composed of terpenoids, flavonoids, phenols, organic acids, and volatile oil Modern pharmacological studies have indicated that *I. cappa* has many biological activities and exerts anti-inflammatory, analgesic, antibacterial, antitumor, antioxidant, and immunomodulatory effects. Compared with the many studies on the pharmacological properties and chemical composition of *I. cappa*, there are few pharmacokinetic studies on its active ingredients, and cellular pharmacokinetic studies on its active ingredients are still lacking. In fact, classical pharmacokinetic studies based on the determination of plasma drug concentrations may not be sufficient to predict pharmacological response *in vivo*. Many drugs must pass through multiple biological barriers before they reach the intracellular target [3].

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue I January 2026

Figure 13.0. Inula cappa

There is a pressing need to expand classic pharmacokinetics from macroscopic plasma concentrations of drugs to the cellular or subcellular levels. *Duhaldea cappa* is a shrub that grows to 1.5 m tall in the grasslands of China, Vietnam, Thailand, Malaysia, Pakistan, Bhutan, Nepal and India. The root is serpentine. The stems are hairy. The leaves are simple. The petiole is 0.5 cm long. The blade is dull green above, elliptic, 8–20 cm × 2.5–6 cm, coriaceous, rounded at base, serrate, acute at apex and hairy and light green beneath (Figure 13.0). The inflorescence is a terminal corymb of golden yellow capitula. The ray florets are yellow, 0.5 cm long and tubular. The disk floret corolla is yellow and 0.6 cm long. The achenes are cylindrical, minute, hairy and whitish *Inula* cappa, a medicinal herb known as "Yang er ju" in Chinese, is widely distributed in the southern part of China. Its whole plant or roots have long been used for the treatment of rheumatoid arthritis, malaria, dysentery, and hepatitis [4]. Previous investigations of this plant reported the isolation of germacrane-type sesquiterpene lactones, along with inositol derivatives [5], flavonoids, and phenolic glycosides. The highly oxygenated germacrane-type sesquiterpene lactones showed potent cytotoxic activity. Woolly under shrubs or shrubs, ca. 1-2.5 m tall, stout; stems corymbosely branched, with very stout branches. Leaves simple, alternate, spiral; lamina ca. 5-15 x 1.5-5 cm, narrowly elliptic or elliptic-lanceolate, acute or rounded at base, acute-subacute at apex, margins distantly cuspidate-serrate, upper surface pubescent with adpressed mammillate hairs, undersurface silky villous or woolly [6,7].

**PLANT PROFILE**

- Kingdom: Planate
- Class: Magnoliopsida
- Order: Asterales
- Family: Asteraceae
- Genus: Inula
- Species: cappa
- Botanical name: *Inula cappa*
- Vernacular Names: Duhaldea, Sheep’s Ear, Fragrant inula, Nepali- Gaaitihaare, Kaanpaate, Baakhraa kaane, Tihaare phool [8,9].

## LITERATURE REVIEW

*Innula cappa* has been reported to contain nerolidol (25.3%), isocostic acid (10.1%), costic acid (8.0%), neo-intermedeol (6.4%) and caryophyllene oxide (5.5%) as major components. p-cymene (30.1%), 1-methylethyl-trimethylbenzene (18.7%), scopoletin (15.3%) and α-pinene (13.1%) are reported as major components from

Inula cappa L. There are two reports on the essential oil of I. cappa [10]. The first one (16) reveals thymol (5.1%), thymyl isobutyrate (87. 7%) from its roots, germacreneD-4-ol (4.5%), 8α-hydroxy presilphiperfolene (43.1%) from leaves and isoledene (6.5%), seychellene (10.3%), 8α-hydroxy presilphiperfolene (37.1%) from its flowers. The second report shows presilphiperfolene-8-ol (17.4), ar-curcumene (17.0%), (E)-β-farnesene (8.2%), isoledene (6.7%), pÏresilphiperfol-7-ene (5.5%), and β-caryophyllene (4.1%) from its leaves [11]. Some chemical constituents viz; Aurantiamide acetate, aurantiamide benzoate, physcion, scopoletin, vanillin, coniferyl aldehyde, syringaldehyde, syringic acid, luteolin, apigenin, azelaic acid, dotriacontanic acid 4-[(6-O-(E)-caffeoyl)-β-D-glucopyranosyl] vanillic acid, 3-O-[β-D-apiofurarnosyl-(1–6)-β-D-glucopyranoxy]-6-hydroxy-p-cymene and (-)-hydnocarpin-7-O-β-D-glucoside were isolated and reported from the *Inula cappa DC* [12]. *Inula cappa* used for various diseases. Anodyne, antichloristic, carminative, depurative, expectorant dispels clots. The juice of the root is used in the treatment of peptic ulcers, indigestion and other gastric disorders. A decoction of the root is used in the treatment of fevers [13]. The decoction is also added to bath water in order to relieve body aches caused by hard physical work. A poultice made from the pounded root is applied to the forehead to relieve headaches. The juice of the bark, mixed with equal quantities of the juice from the bark of Ficus semicordata and Myrica esculenta is used in the treatment of menstrual disorders [14].

### Plant Material

Fresh plant material of *Inula cappa* (leaves, flower) was collected from Dhanolti region in month of September and October. Plant was identifying by botany department of HNBGU Srinagar Garhwal. The fresh flowers were hydro distilled for 8 hrs to get the colorless essential oil. Dried leaves were Successive extracted for extracts in different solvent (petroleum ether, chloroform, and methanol). The essential oil was stored in a sealed vial for further analysis.

## RESULTS

### GC-MS of Essential Oil

The GC-MS analysis of *Inula cappa* resulted in the identification of Sixteen Constituents. Both the major as well as minor constituents were identified by their retention indices**.** Results are shown in Figure No.13.1 and Table No.13.1.

Figure No. 13.1: GCMS Spectra of composition of Essential oil

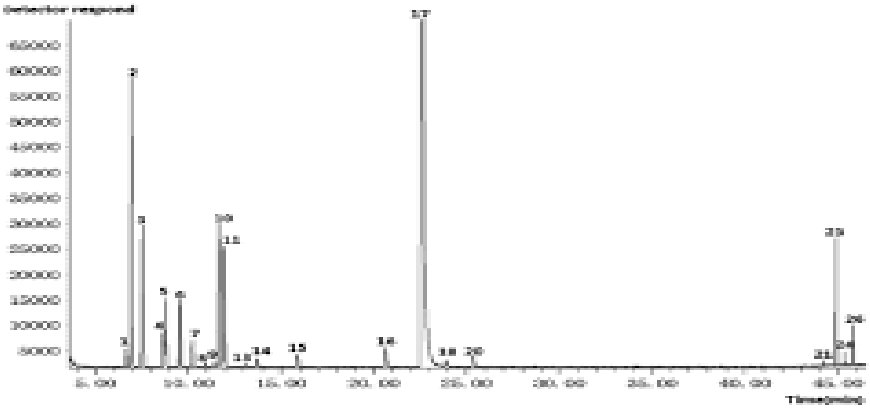


Table No. 13.1: Essential Oil Composition of *Inula cappa*

| S.No | Compound | Molecular Formula | Molecular Weight | RT |
|---|---|---|---|---|
| 1. | α-tujene | $C_{10}H_{16}$ | 136.23 | 5.1267 |
| 2. | α-pinene | $C_{10}H_{16}$ | 136.23 | 5.3370 |

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue I January 2026

| | | | | |
|---|---|---|---|---|
| 3. | Camphene | $C_{10}H_{16}$ | 136.23 | 6.4024 |
| 4. | Sabinene | $C_{10}H_{16}$ | 136.23 | 6.5222 |
| 5. | β-pinene | $C_{10}H_{16}$ | 136.23 | 6.7294 |
| 6. | Mircene | $C_{10}H_{16}$ | 136.24 | 7.4816 |
| 7. | Terpinolene | $C_{10}H_{16}$ | 136.24 | 8.3441 |
| 8. | trans ocimene | $C_{10}H_{16}$ | 136.24 | 8.7020 |
| 9. | γ-terpinene | $C_{10}H_{16}$ | 136.24 | 9.0658 |
| 10. | trans sabinene hydrate | $C_{10}H_{18}O$ | 154.24 | 9.5273 |
| 11. | Terpinolene | $C_{10}H_{16}$ | 136.24 | 10.0223 |
| 12. | Linalol | $C_{10}H_{18}O$ | 154.24 | 12.6253 |
| 13. | terpinene-4-ol | $C_{10}H_{18}O$ | 154.24 | 19.7439 |
| 14. | Methyleugenol | $C_{11}H_{14}O_2$ | 178.22 | 20.1727 |
| 15. | β-caryophyllene | $C_{15}H_{24}$ | 204.35 | 21.2563 |
| 16. | Elemicin | $C_{12}H_{16}O_3$ | 208.25 | 24.8396 |

**Phytochemical analysis**

The solvent extracts viz. petroleum ether, chloroform, methanol and water were used for Phytochemical screening. The results showed the presence of all Phytochemical viz. carbohydrates, alkaloids, glycosides, flavonoids, phenols, saponins and tannins in the Methanolic extracts of the leaves of Inula cappa while chloroform extracts showed the presence of carbohydrates, alkaloids, flavonoids and saponins while tannins and glycosides were found to be absent. Water (aqueous) extracts were found to have carbohydrates, alkaloids and flavonoids while saponins, tannins and glycosides were found to be absent. Chloroformic and hexane extracts were found to have saponins and glycosides. Results shown in Table No. 13.2.

Table No. 13.2: Phytochemical screening of different extract of Inula cappa

| **S.No.** | **Test** | **PE** | ***CE*** | ***ME*** | ***AQE*** |
|---|---|---|---|---|---|
| **1.** | Carbohydrates- Molisch's test | + | - | + | + |
| | Fehling's test | + | - | + | + |
| | Benedict's test | + | - | + | + |
| **2.** | Alkaloids- Mayer's test | + | - | - | + |
| | Wagner's test | + | - | - | + |
| | Dragendroff's test | + | - | - | + |
| **3.** | Glycosides- Killani's test | + | + | - | + |

| | | | | | |
|---|---|---|---|---|---|
| | Legal's test | + | + | - | + |
| **4.** | Phenols- Folin – Ciocalteau's test | - | + | - | + |
| **5.** | Flavonoids- $H_2SO_4$/Mg test | - | + | - | + |
| **6.** | Saponin- Foam's test | - | - | + | + |
| **7.** | Tannins- Gelatin's test | - | + | + | + |

**Anti-oxidant activity**

The results of the antioxidant activity suggest that, polar extracts of Inula cappa *had* significant antioxidant potential in comparison to non-polar extracts. The result of antioxidant activity follows the order as-

Methanolic extract>petroleum ether extract>chloroformic extract>water (aqueous) extract. The results are shown in **Table No.13. 3.**

Table No. 13.3: Antioxidant activity of different extract of *Inula cappa*

| **Extracts and Standard** | **DPPH free radical scavenging activity (IC50)** |
|---|---|
| PEE | 8.63±0.33 |
| CE | 19.79±0.28 |
| ME | 25.01±0.53 |
| AQE | 40.10±0.23 |
| Standard (Ascorbic acid) | 47.02±0.08 |

**Antimicrobial activity**

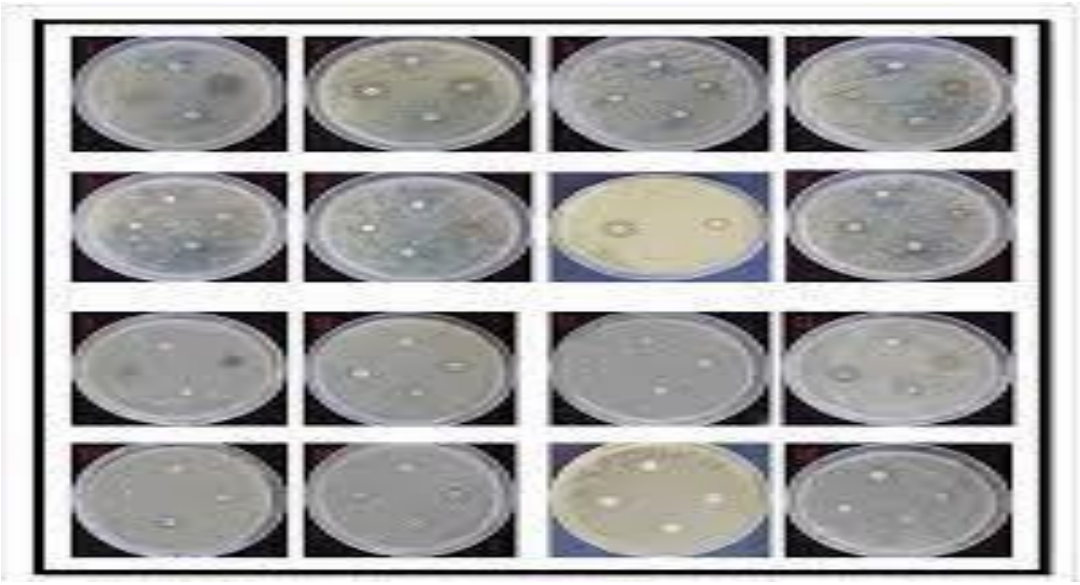
The antimicrobial activities of polar and non-polar solvent extracts of the leaves of *Inula cappa* were determined against *E. coli*, *B. subtilis* and *S. aureus* via well diffusion method. The significant highest zone of inhibition was recorded of polar extracts against all the bacterial strains studied in comparison to non-polar extracts. The results of antimicrobial activity follow the order as- Methanolic extract> Hydro-alcoholic extract>water (aqueous) extract> Hexane extract> chloroformic extract> petroleum ether extract. The results are shown in Table No. 13.4 and Figure No. 13.2.

Table No. 13.4: Antimicrobial Activity of Solvent Extracts of Leaves of *Inula cappa*

| **Bacterial Pathogen** | **Diameter of zone of inhibition (mm)** | | | |
|---|---|---|---|---|
| | **ME (100µg/ml)** | **AQE (100 µg/ml)** | **CE (100 µg/ml)** | **PE (100 µg/ml)** |
| ***B. subtilis* (MTCC 441)** | 8.63 | 13.2 | 12.09 | 0.71 |
| ***S. aureus*(MTCC 441)** | 14.02 | 6.15 | 7.2 | 12.34 |
| ***Pseudomonas aeriginosa* (MTCC 441*)*** | 5.19 | 11.5 | 9.1 | 14.6 |

| | | | | |
|---|---|---|---|---|
| ***Proteus vulgaris* (MTCC 441)** | No Zone | 4.05 | 8.9 | 7.9 |
| ***E. coli* (MTCC 441)** | 17.02 | 7.9 | 11.2 | No Zone |
| ***Klebsiella pneumnia* (MTCC 441)** | 0.19 | No Zone | 12.3 | 10.05 |

Figure No. 13.2: Antimicrobial activity of different extract of *Inula cappa*



## DISCUSSION

*Inula cappa* have many qualities and features including anti-inflammatory, antitumor, anti-bacterial, and antifungal and various other and possesses great influence on nervous system. Various studies can be conducted in multiple animal-based models for understanding their mechanism of action.

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