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Kundur (*Boswellia Serrata*): Medicinal Importance in Perspective of Unani Medicine and Pharmacological Studies

Huziafa Ashfaq Salati[1], Mohd. Afsahul Kalam[*2], Tooba Bilal Wani[3], Urzeeba Zahoor[1], Uzma Jan[1], Ajaz Ahmad Bhat[1]

[1]PG Scholar Department of *Ilmul Advia*, Regional Research Institute of Unani Medicine, University of Kashmir, Habak, Naseembagh Campus, Hazratbal, 190006, J&K, India.

[2]Research Officer Unani, Regional Research Institute of Unani Medicine, University of Kashmir, Habak, Naseembagh Campus, Hazratbal, 190006, J&K, India.

[3]PG Scholar Department of *Moalajat*, Regional Research Institute of Unani Medicine, University of Kashmir, Habak, Naseembagh Campus, Hazratbal, 190006, J&K, India.

[*]Corresponding Author: Mohd. Afsahul Kalam

Research Officer Unani, Department of *Ilmul Advia*, RRIUM, University of Kashmir, Habak, Naseembagh Campus, Hazratbal, Srinagar, 190006, J&K;

ABSTRACT: *Kundur*, the Indian olibanum tree, is a member of the Burseraceae family and grows best in the dry mountainous regions of the Middle East, Northern Africa, and India. This tree has small to huge branches. The tree's oleo-gum resin is removed and stored from the incision created in its trunk. Resin makes roughly 30–60% of oleo-gum resin, with organic solvent-soluble essential oils making up the remaining 5–10%. Gum-resin extracts from *Boswellia serrata* have long been used in traditional medicine to treat a variety of chronic inflammatory diseases. Four primary pentacyclic triterpenic acids found in the resinous component of *Boswellia serrata* are β-boswellic acid, acetyl-β-boswellic acid, 11-keto-β-boswellic acid, and acetyl-11-keto-β-boswellic acid. This oleo-gum resin is quite popular among traditional practitioners of traditional Chinese and Indian Systems of medicine because of its wide range of useful biological properties such as anti-inflammatory, anti-arthritic, anti-rheumatic, anti-diarrheal, anti-hyperlipidemic, anti-asthmatic, anti-cancer, anti-microbial, anti-fungal, anti-complementary, and analgesic activity etc.

KEYWORDS: *Kundur*, *Boswellia serrata*, Unani, oleo-gum resin, Anti-arthritic

ABBREVIATIONS: BS: Boswellia serrata, BA's: Boswellic acids, AKBA: acetyl 11-keto-beta BA

INTRODUCTION

As the name implies, the Unani medical system originated in ancient *Yūnān* (Greece), and it was later expanded by physicians from Roman, Arabic, Spanish, Iranian, and Indian backgrounds. Thus, Greco-Arab Medicine got its name. It is a thorough medical system that carefully addresses the different levels of health and illness. It offers healthcare that is promotive, preventive, curative, and rehabilitative. Based on the teachings of Greek physician *Buqrāt* (Hippocrates, 460–370 BC) and Roman physician *Jālīnūs* (Galen, 129–210 AD), Unani medicine was transformed into medical science. Arab and Persian physicians, including *Al-*

Rāzi (Rhazes, 850–925 AD), *Ibn Sīna* (Avicenna, 980–1037 AD), *Al-Zahrāwi* (Abulcasis, 936–1036 AD), and *Ibn Nāfis* (1213–1288 AD), developed the elaborate medical system[1,2]. People's belief in the safety and effectiveness of Unani medicine is driving growing demand for it. In Unani system of medicine, many individual and combination medications are utilized to treat various clinical conditions. One such drug is "*Kundur*" (*Boswellia serrata*) which is a deciduous middle-sized tree belonging to the family of Burseraceae[3]. The Burseraceae family is an important family in southern Arabia and Africa. The Boswellia genus has 19 reported species with centres of endism in Yemen and Africa, whereas the rest are distributed across the African, Arabian and Indian continents. The most frequently studied species are *B. sacra, B. serrata, B, papyrifera and B. frereana*[4]. Its Sanskrit name, "*Gajabhakshya*" implies its ingestion by elephants. It has been described as useful by *Charaka, Bhavamisra* and others[5]. It is common on dry hills throughout the greater part of India except Assam and Burma. This tree, on injury, exudes an oleo-gum resin known as Indian Olibanum or Salai Guggul, which is used as a diaphoretic and astringent, and in the preparation of an ointment for sores. The oleo-gum resin secreted from the cortex is fragrant, transparent and golden-yellow and solidifies to brownish yellow tears or drops and crusts, varying from pea-size to walnut-size[6]. Pearson and Puran Singh have given very complete information as to the occurrence, mode of collection, chemistry, and technical handling of the gum-oleoresin. The gum appears to resemble true gums in that it yields sugars like arabinose, xylose and galactose on hydrolysis[3]. Generally four grades of gum-resin are known:

Superfine grade is translucent, very light yellow in colour, free from bark and other impurities. Quality I is brownish yellow, less tranlucent and free from bark and impurities.

Quality II is brownish, semi-translucent and may have some impurities.

Quality III is dark brown, opaque and with impurities[6].

The essential oil of *Boswellia serrata* was found to be antifungal. Anti-inflammatory and antibacterial activity of extracts have been demonstrated[5]. Oil from oleoresin of this plant contains high content of α-thujene and reduced cholesterol biosynthesis in rat liver at 100 mg/kg but not at 25 or 50 mg/kg[7]. Some of the metabolites isolated from its bark are carbohydrates, glucosides and β-sitosterol[8].

The major goal of this manuscript is to highlight the *Kundur*'s therapeutic efficiency in various illnesses based on its pharmacological activities and phytoconstituents.

MATERIALS AND METHODS

The temperament, therapeutic applications, and medicinal qualities of *Kundur* were studied in classical Unani literature. To gather all the information on its phytochemicals and pharmacological investigations that was available, published publications that were accessed through PubMed, Science Direct, and Google Scholar were consulted. All pertinent articles were cited, including research studies, review papers, and classic Unani literature. The scientific name of the plant was confirmed utilising Plants of the World Online facilitated by the Royal Botanic Gardens, Kew and published on the Internet; https://powo.science.kew.org/. To describe the relevant Unani terminologies, the Central Council for Research in Unani Medicine, in partnership with the World Health Organisation, released Standard Unani Medical Terminology was used. For botanical description, Indian Medicinal Plants, Flora of British India and Medicinal herbs with their formulations were availed.

OBSERVATIONS

Geographical distribution

A genus of Boswellia is distributed in tropical Asia and Africa. Two species occur in India including *B. serrata*, the Indian olibanum tree. It is commonly found in the dry forests from Punjab to West Bengal, and in

peninsular India. The tree is common at the foot of the western Himalayas, in Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Bihar, Orissa, Andhra Pradesh and further south in the peninsula[6]. The native range of this species is Indian Subcontinent. It grows primarily in the seasonally dry tropical biome[9].

Botanical Description

A medium-sized, deciduous tree with pubescent new branches and leaves; the bark is ash-coloured and peels off in thin flakes. The leaves are 20-38 cm long, with opposite leaflets measuring 2.5-6.3 by 1.2-3 cm. These leaflets are sessile, with 8-15 pairs and an odd one (the pair at the base of the leaf is often much smaller than the others). The leaves can be ovate or ovate-lanceolate, with varying shapes such as obtuse or ovate-lanceolate, usually inequilateral, crenate-serrate, or somewhat truncate. Shorter than the leaves, flowers are arranged in axillary racemes. Lobes are widely triangular-ovate; calyx pubescent outside. Petals: 5 mm long, oval, hairy on the outside, inflexed at the ends. The anthers are slightly hairy, and the stamens are inserted at the base of an annular crenate disc. The disc encircles the ovary; the style is grooved; Cotyledons trifid; pyrepes heart-shaped; drupe trigonous[3,10,5].

Flowering: It occurs during January-April when the tree is almost leafless.

Fruiting: Fruits ripen during May-June[6].

Taxonomical Classification[11,12]

Kingdom: Plantae
Phylum: Angiosperms
Class: Eudicots
Order: Sapindales
Family: Burseraceae
Genus: Boswellia
Species: Serrata

Description in Unani literature:

Kundur is an oleo-gum resin of a thorny tree 2-3 yards tall. Its leaves are similar to the leaves of *Pistacia atlantica* but are a little smaller. According to some, its leaves and seeds resemble with the leaves and seeds of *Ās* (*Myrtus communis*). Its taste is bitter and its origin is in the cities of Oman and Yemen. Its colour turns red as it becomes older. But in the book of *Al-Qānūn*, it has been mentioned that Dioscorides states that *Kundur* once originated in the city of *Kundur*, the name of a well-known town among the Greeks. But it can also occur in the cities of India. The shelf-life of *Kundur* lasts for twenty years and its better form is fresh, soft and pure. The property of pure *Kundur* is that it is white on the outside and yellowish within and also it flames in the fire[13,14,15]. The gum produced from this is called *Kundur*. At sites, where the tree is cut and left injured, the sap appears in the form of gum which is then preserved. The Unani name of *Kundur* is "*Libanu"*, it is that *Kundur* which is found in the cities of the western region. The best kind of all is *Kundur Jabāl* which is a male plant and is called as "*Satav Nees*". It is found in the form of round grains, having hard white gum that is not easily breakable. On breaking it, a sticky substance is found, which burns very quickly when burnt as incense[15].

Fig. 1 Shows Oleo-resin Kundur (*Boswellia serrata*)

Mutarādifāt **(Vernacular names)**[3,15,16]**:**

Unani:	*Kundur*
Ayurvedic:	*Shallaki, Susravaa, Salai*
Arabic:	*Luban, Kundur*
Hindi:	*Kundur, Lobān, Salai*
Tamil:	*Parangichambrani, Attam*
Folk:	*Salai Guggal*
Siddha:	*Kungli*
Telugu:	*Parangisambrani, Anduga*
Persian:	*Kundur*
Urdu:	*Kundur, Lobana*
Sanskrit:	*Ashvamutri, Kunduru*
English:	Indian frankincense tree or Indian Olibanum tree

Ajzā-i-Musta'mila **(Parts used)**[5]

Chāl (Bark) and *Gond* (gum)

Mizāj **(Temperament)**

Hot and dry in 2nd degree. As per Ibn Sina, its temperament is dry in 1st degree[13]. *Ibn Baytar* in his book, *Al-Jami Li-Mufradāt- al-Advia wal Aghdhiya* mentioned its temperament to be hot and dry in 3rd and 1st degree respectively[15]. Some mentioned its temperament to be Hot and dry in 3rd degree[13].

Miqdār Khūrāk **(Dose):**

Oleo-resin: 1-3 g thrice a day[5,13].

Af'āl **(Actions)**

It has got *Kāsir-i-Riyāh* (carminative), *Hābis* (haemostatic), *Kābiḍ* (astringent), *Muḥallil* (anti-inflammatory), *Dāfi'a Nisyān* (anti-dementia activity), *Dāfi'a Qurūh* (anti-Ulcer activity), *Muqawwī-i-Qalb* (cardiac tonic)[13,15], *Mudirr-i-bawl* (diuretic), *Mudirr-i-Ḥayḍ* (emmenagogue)[14], *Dāfi'a Ta'affun* (anti-septic)[17] properties. *Hubul Baghdādī* in *Kitab al Mukhtarat fil tib* mentioned its actions to be *Muḥallil-i-Awarām* (Anti-inflammatory), *Mundamil* (healing agent), *Muqawwī Hāfiza* (memory stimulant), *Musakkin-i-Dard* (analgesic)[18].

Iste'mālāt (therapeutic uses)

It is being included in the paste formulations for resolving *Waram-i-Ahshā* (visceral inflammation) and used as a healing agent in *Zakhm* (fresh wounds). Using it internally helps to strengthen memory. It is proven to be useful in *Zūsantāriyā* (dysentery), *Ishāl* (diarrhoea), *Shiqāq al-Maq'ad* (anal fissure)[18]. *Najmul Ghani* in *Khazāinul Advia* mentioned its use in *Khafaqān* (palpitations), *Surfa Muzmina* (chronic cough), *Qurūh al-Qarniyya* (corneal ulcers)[13].

Tarkīb Iste'māl (Method of administration)[3,13,17]

The method of administration of *Kundur* is mentioned in Tablee 1.

Table 1: Shows the method of administration of *Kundur* in various diseases

S.no.	Diseases	Method of administration/application
1	*Nisyān and Fasād-i-Zikr* (Neurocognitive disorder)	Along with honey useful in dementia, *Fasad-i-Zikr*, and *Ḥumq* (mental retardation).
2	*Amrāḍ Ālāt-i-bawl* (Diseases of the urinary system)	*So'd Kūfī* (*Cyperus rotundus*) and *Kundur* in equal quantities to be ground and 4 g to be taken in the morning for *Taqṭīr al-Bawl* (dribbling of urine).
3	*Amraḍ Sha'r* (Diseases of hair)	Along with *Natrūn* (sodium carbonate) massaged on the scalp helps to get rid of *Bafā* (dandruff).
4	*Amrāḍ Nazf al-dam* (Bleeding disorders)	Taken with *Gil-i-Aramanī* in *Ru'āf* (epistaxis).
5	*Naḥsh* (Bites)	The gum oleo-resin is recommended in combination with other drugs for treating snake bites and scorpion stings.
6	*Qurūh* (Wounds)	Mixing the ground *Kundur* with coconut oil and applying it as an ointment is very helpful in healing wounds.

Maḍarrat (Toxicity, side effects and adverse effect)

With the recommended doses side effects are uncommon. Occasionally patients may complain of heartburn or warmth of hands and feet[5].

It produces headache in hot temperament people[14], its overdose causes the combustion of phlegm and blood. It is harmful to the lungs[13].

Musleh (Correctives)

To counter its adverse or side effects *shakkar* (sugar), *Unnāb* (*Zizyphus mauritius*), and sikanjbīn are used as corrective[13,14].

Badal (Substitutes)

In case of non-availability of *Kundur*, *Masṭagī* (*Pistacia lentiscus* Linn) can be used as a substitute[13].

Mashūr Murakkabāt (Compound formulations)

Compound formulations of *Kundur* are given in **Table 2.**

Table 2: shows Unani formulations having *'Kundur'* as one of the ingredients with their dose, and uses[19,20].

Compound formulations	Dose and route of administration	Uses
Ma'jūn Nisyān	4.5 g p.o	Dementia
Ma'jūn Kundur	10.5 g p.o	Nocturnal enuresis
Marham-i-Rusl	Locally	Wounds, piles, scrofula
Mufarriḥ Kabīr		Palpitations, chronic fever, chronic diseases
Roghan-i-Kalān	Locally	Paralysis, facial palsy
Safūf-i-Māsikul bawl	10.5 g with water p.o	Polyuria, urinary incontinence
Sanūn-i-Supārī	Locally	Bleeding gums
Jawārish Kundur	10.5 g p.o	Palpitations, phlegmatic diarrhoea, enhance digestion

CHEMICAL CONSTITUENTS

The major components of essential oil are: α-thujene, α-pinene, sabinene, δ-3-carene, α-phellandrene, limonene, α- and β-thujone and β-bourbonene. The seed yields a fixed oil[21]. Analysis of the non-volatile fraction of the oleo-gum resin yielded a new diterpenic alcohol, β-amyrin, methylchavicol and triterpenic acids, viz., 3-α-acetoxytirucall-8, 24-dien-21-oic acid, β-boswellic acid, acetyl-β-boswellic acid, 3-ketotirucall-8, 24-dien-21-oic acid, acetyl-11-keto-β-boswellic acid etc[6]. GC/MS analysis of its volatile oil is given in table 2.

Table 2: GC/MS Analysis of the Volatile Oil of *B. serrata* Oleo-gum resin[22]

COMPOUND NAME	
Monoterpenes	α-Thujene Sabinene Terpinen-4-ol Cis-Carveol
Phenols	Chavicol
Monoterpenoids	Linalool Terpinyl acetate
Sesquiterpenes	β-Caryophyllene
Anisole	Elemicin
Sesquiterpenoids	β-Copaen-4-α-ol Germacrene D

PHARMACOLOGICAL STUDIES

Antiarthritic and anti-inflammatory activity

Carrageenan and dextran are commonly used to generate paw oedema to test the anti-inflammatory properties of medicines. Singh and Atal found that an alcoholic extract of BS's oleo-gum resin reduced carrageenan-induced oedema in rats and mice, as well as dextran-induced oedema in rats. Numerous scientific research confirm that BS has strong anti-inflammatory properties. B. serrata extract inhibits carrageenan-induced paw oedema by 39.75% and 65-73% at doses of 50-200 mg/kg p.o and 50-100 mg/kg i.p, respectively, compared

to 47% inhibition with phenylbutazone (50 mg/kg p.o.). Adrenalectomized rats also demonstrated anti-inflammatory effects.

Inhibition of paw swelling (34% and 49%) has been seen with the mycobacterial adjuvant-induced polyarthritis in rats[23].

Analgesic effect

B. serrata is utilized to treat muscle and joint pain in various medical systems[24,25,26]. Menon and Kar demonstrated that the non-phenolic fraction of B. serrata had a significant analgesic and sedative effect. They also discovered a considerable reduction in spontaneous locomotor activity after treatment with Boswellia[27]. Sharma et al. evaluated the analgesic activity of various fractions of B. serrata in rats using the formalin test, acetic acid-induced writhing, hot plate procedures, and the tail immersion model of analgesia[26]. Both peripheral and centrally mediated analgesic effects were assessed. The tail immersion method and acetic acid-induced abdomen constriction revealed central and peripheral activity, respectively, while the formalin test examined both. The hot plate method[28] was used to investigate peripheral effects. They not only evaluated the analgesic effect but also determined the mechanism of action. The oleo-gum resin fraction demonstrated the highest inhibition (60.54%) compared to the gum (54.88%) and oil (20.70%) fractions. In 2005, Bishnoi et al. investigated the analgesic effect of AKBA at various dose levels in mice using the tail-flick and acetic acid-induced writhing methods. In the acetic acid-induced writhing method, AKBA's antinociceptive efficacy increased dose-dependently, whereas, in the tail flick method, 100 mg of AKBA produced a response similar to 200 mg. AKBA was found to perform much better than the positive control, nimesulide[29]. Al-Harrasi et al. used formalin-induced pain and acetic acid-induced writhing to test Boswellia sacra's analgesic efficacy in mice. Polar subfraction exhibited the strongest analgesic effect, nearly double that of the positive control, aspirin. According to the study, Boswellia appears to have antinociceptive effects through both peripheral and central mechanisms[30].

Antifungal activity

Chaurasia and Gharia used the agar well diffusion method to evaluate *B. serrata*'s antifungal effectiveness against the plant pathogenic fungus Colletotrichum falcatum, which causes red rot disease. They extracted the plant with water, ethanol, and chloroform and concluded that the ethanolic extract of the plant was significantly more efficient than the chloroform extract[31].

Garg (1974) investigated the antifungal activity of B. serrata and discovered that hydro-distillation yielded 0.6% of essential oil. The oil shows weak antifungal activity against human diseases and is quite efficient against plant pathogens, as evidenced by suppression of the studied organisms, specifically Phytophthora parasitica[32].

Antihyperlipidemic and antidiabetic activity

Olibanum gum resin has traditionally been used in the treatment of diabetes in patients and has been recognized with its beneficial effects in a large number of diseases. Several investigations in rat's model showed that BSE of olibanum gum resin significantly decreased total cholesterol and has potential hypolipidemic and hepatoprotective activities[33,34]. A study has also been carried out for comparison between olibanum resin and placebo for the curing of type 2 diabetes in double-blinded clinical trial on 71 patients. They suggested that olibanum gum resin improves glycemic control and lowers the blood levels of glucose, HbA1c, insulin, total cholesterol, and triglycerides[35]. An herbal formulation of *B. serrata* gum resin has been documented to induce powerful hypoglycemic effect by affecting hepatic gluconeogenesis and phosphoenolpyruvate carboxykinase[36]. At different dose levels (25–50 mg/kg. p.o.), the alcoholic extract exhibited antihyperlipidemic activity with hypercholesterolemic animals and lowered cholesterol (30–50%) and triglycerides (20–60%) levels[37]. The past studies and research clearly revealed that Boswellia is an

effective antihyperlipidemic agent. Hydrophilic portion of BSE enhanced high-density lipoprotein and diminished the concentration of total cholesterol (38–48%) in experimental animals. Zutshi et al. observed that Salai guggal retains optimum levels of serum cholesterol and triglycerides in animals, which were fed high cholesterol and saturated fat-rich diet[38]. AKBA has been exhibited to inhibit the activity of nuclear factor kappa B (NF-kB) in atherosclerosis. Liu et al. found that AKBA is known to have anti-adipocyte property by virtue of which it induces lipolysis in mature human adipocytes[39].

Antidiarrheal activity

BAs from *B. serrata* were effective in controlling diarrhoea without causing constipation in patients with inflammatory bowel syndrome. They also inhibited the contraction of intestinal smooth muscles, thereby controlling acetylcholine and barium chloride-induced diarrhea[40].

Anticancer activity

BSE has been demonstrated to inhibit brain tumours as well as breast cancer metastases. In mice, BSE, which contains 60% BAs, appears to suppress inflammation and tumour formation. The anti-neoplastic impact was tested in mice with Ehrlich ascites carcinoma and S-180 tumour by interfering with the manufacture of DNA, RNA, and protein, which inhibited cell proliferation. The effectiveness of BSE against peritumoral edema can be increased by increasing the bioavailability of AKBA[41]. *B. serrata* shows anticancer activity in a variety of tumour cells, including prostate, colon, leukocytes, brain, and liver.

AKBA inhibited NF-kB and increased apoptosis and angiogenesis in neoplastic cells via the signal transducer pathway and transcription 3-related pathways[42,43,44,45,46,47,48]. Furthermore, Sinha et al. demonstrated that BAs block basic fibroblast growth factor-induced angiogenesis in vivo using the Matrigel plug assay[49]. Ahmed et al. investigated the effectiveness of B. serrata methylene chloride extract in treating colon cancer in rats. They also used ELISA to assess serum epidermal growth factor, matrix metalloproteinase (MMP)-9, MMP-7, plasma transforming growth factor-β (TGF-β), and TNF-α levels. Cyclin D1 and colon cyclooxygenase-2 (COX-2) expressions were measured using immunohistochemistry. The colon cancer group had a sufficient increase in cyclin D1 and COX-2 expression in colon cells, whereas all therapy groups showed a significant decrease in cyclin D1 and COX-2 expression. This study examined the therapeutic role of B. serrata against colon cancer in rats[50].

Antimicrobial and antioxidant effects

Ismail et al. found that the resin extract of Salai guggal powder had microbicidal activity against Gram-negative (Proteus vulgaris, Klebsiella pneumonia, Pseudomonas aeruginosa, Escherichia coli, and Enterobacter aerogenes) and Gram-positive (Staphylococcus aureus, Bacillus subtilis, and Streptococcus pneumonia) microbes at various concentrations (25, 50, 75, and 100 mg/ml). The inhibitory zone was detected and compared with ciprofloxacin (5 µg/ml) as a positive control and dimethyl sulfoxide as a negative control[51]. Patel and Patel used the disk diffusion method to assess the antibacterial activity of B. serrata extracts in acetone, water, methanol, and petroleum ether against Gram-negative urinary tract infection pathogens (K. pneumonia, E. coli, P. vulgaris, and P. aeruginosa). The acetone extract shown considerable antibacterial activity against K. pneumonia and E. coli, with a minimum inhibitory concentration value of 12.5 µg/µl[52]. Baratta et al. (1998) investigated antibacterial and antioxidant activity and identified the essential oil of B. serrata using gas chromatography (GC) and GC-mass spectrometry. The volatile oil fraction demonstrated strong antibacterial activity against all tested species and comparable antioxidant activity to butylated hydroxytoluene and α-tocopherol[53]. Raja et al. investigated the antibacterial activity of BAs against a wide range of pathogenic Gram-negative and Gram-positive bacteria and determined that AKBA was the most effective element with antibacterial potential among all BAs, but exclusively against Gram-positive bacteria[54].

CONCLUSION

This review suggests that in Unani system of Medicine, *Boswellia serrata* is mentioned to exhibit extensive array of actions based on which it has multitude of therapeutic uses in neurological disorders, diseases of urinary system, bleeding disorders, wounds and ulcers, diarrhea, cough, arthritis, inflammation, skin disorders. *Boswellia serrata* has been demonstrated to have antiulcer, anti-diarrheal, anti-inflammatory, and antibacterial activities, making it effective in inflammatory bowel conditions. Boswellic acid, tannin, phenol, and β-sitosterol are among the phytochemicals responsible for these functions. This comprehensive analysis highlights the diverse pharmacological characteristics of the traditional medicine *Kundur* (*Boswellia serrata*). Future challenges include identifying molecular mechanisms at the cellular level, drug-drug interactions, developing techniques to improve pharmacokinetic parameters, particularly oral bioavailability, and developing a stable preparation.

CONSENT AND ETHICAL APPROVAL

It is not applicable

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COMPETING INTERESTS

The authors have declared that no competing interests exist**.**

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