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Zanjabeel (Zingiber officinale Roscoe.): An Evidence-Based Review of Anti-nociceptive, Anti-inflammatory, Antioxidant, and Antimicrobial Properties

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Authors' contributions

This work was carried out in collaboration among all authors. Author FK wrote the manuscript and did the literature searches. Authors MN and ANA did the editing. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Ginger has been appreciated for over 2500-3000 years in many parts of the world due to its numerous scientific properties. The ginger plant (*Zingiber officinale* Roscoe) belongs to the Zingiberaceae family. It is a known food and flavoring ingredient reputed for its wide range of medicinal properties that have been widely used in Chinese, Ayurvedic, and *Unāni* Tibb worldwide, since antiquity. Ginger has long been used to cure a variety of ailments, including diarrhea, stomach discomfort, indigestion, and nausea. It is a versatile herb with phenomenal phytotherapeutic and medicinal properties. Active ingredients available in ginger such as 6-gingerol, 6-shogaol, 6-paradol, and zingerone are responsible for upgrading enzyme actions and balancing circulation through rejuvenating the body with physical re-strengthening. Gingerols, the key phenolic plant secondary metabolites responsible for its distinct flavor and health benefits, are found in the rhizome of ginger Extensive study has been undertaken over the last two decades to uncover bioactive ingredients and the therapeutic potential of ginger. This review considers

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ginger's chemical composition and the most recent study findings on its possible health advantages, such as analgesic, anti-inflammatory, antibacterial, and antioxidant properties due to its phytochemistry. Overall, clinical trials are needed to confirm these prospective various health advantages of ginger in human subjects and the most efficacious dosage, based on the current body of scientific literature.

Keywords: Ginger; zingiber officinalis; zanjabeel; analgesic; anti-inflammatory; gingerol.

1. INTRODUCTION

Ginger dates back to over 2500-3000 years to Vedic times [1]. The Arabic physicians knew it as *Zanjabeel* [2]. Since antiquity, ginger has been widely employed in Chinese, Ayurvedic, and *Unani* herbal treatments for a variety of diseases all across the world [3-5]. The Spaniards brought ginger to Mexico and then introduced it to Jamaica and became the world's foremost producer of this species [6]. It was used as a spice by the Greeks and Romans, considering it an Arabian product because it came from India via the Red Sea [7,8]. Ginger has been utilized as a medicine in India since the Vedic time, and it is known as '*Maha Aushadhi*,' which means the great medicine [9]. Early literature from Asia, Europe, and the Middle East mentions the beneficial virtues of ginger. Its medicinal properties are mentioned in Ayurveda (Indian system of Medicine) which originated during the 5th century B.C [1,10]. Ginger is a perennial herb with a large, solid, thick-lobed, aromatic, and tough horizontal rhizome [2,7-9,11,12]. The drug is known in commerce as 'unbleached ginger' [7]. When dried it is known as *Sunthi* in distinction from *Adraka*, fresh ginger [10]. The Jamaica ginger is considered to be the best for flavor, and the Cochin next [13]. Indian ginger is regarded as Cochin ginger in the world market [2]. The best ginger grown in India is uncoated Cochin ginger, which has a pale buff color and a striated, fibrous surface. Fresh ginger usage in India is estimated to be between 8 and 10 grams per day [14]. The pungency of fresh ginger is mostly due to gingerols, which are a homologous group of phenolic chemicals, whereas the pungency of dried ginger comes mostly from shogaols, particularly (6)-shogaol, which are dehydrated versions of gingerols [15]. This review discusses the potential health benefits of ginger with special reference to phytochemical composition and physiological benefits such as analgesic, anti-inflammatory, antioxidant, and antimicrobial.

2. MATERIALS AND METHODS

Unāni classical books available in the National Institute of *Unāni* Medicine library were reviewed for information related to Ginger (*Zingiber officinale* Roscoe) such as *Al-Qānūn Fi'l-Ṭibb* (English Translation), *Makhzan-ul-Mufradat*, *Kitab al-Mukhtarat Fit-Ṭibb*, *Muhit-e-Azam*, *Kitab-ul-Umda Fil-Jarahat,* etc. Other published books and journals were also consulted for further details. For information on ginger, major scientific databases, namely Pubmed, Science Direct, Springer, Elsevier, and Scopus for the most recent information regarding its properties, were searched. The search words used were ginger, *Zingiber officinale*, analgesic, anti-inflammatory, antioxidant, bioactive compounds, etc. Time restriction was not made to extract the most useful information. The articles published during 1956–2021 were hence included in the final manuscript.

2.1 Historical Background

The plant was given the name *Zingiber* by English botanist William Roscoe (1753-1831), which was derived from the Sanskrit term *Singabera*, meaning horn-shaped due to the protrusions on the rhizome [16]. The Analects of Confucius, written in China during the Warring States period (475–221 BC), contains the first written record of ginger. Ginger is "one of the oldest recorded spices to be farmed and traded from southwest India, despite being grown all over the world [17]. Since antiquity, ginger has been utilized for medical purposes. It has been an essential plant for traditional Chinese and Indian remedies in particular [5]. The plant is originally from Asia, but it is now grown throughout the West Indies, Africa, India, and other tropical areas. It has been used in culinary applications since the 13th century. The Spanish prized ginger so highly that in the 1600s, they established ginger plantations in Jamaica. The ginger we consume in fresh or dried form is a *Rhizoma zingiberis* drug obtained from *Z. officinale* rhizomes [14]. It has the widest range of applications of any spice, including dietary supplements, beverages, and food products. For millennia, it has been used to cure a variety of ailments throughout Asia, India, Europe, and the Middle East, including arthritis, stomach distress, asthma, diabetes, and menstrual irregularities

[18]. Although ginger extracts have been shown to inhibit arachidonic acid metabolism and have anti-inflammatory and/or anti-rheumatic properties, one of its traditional indications has been to treat rheumatic disorders [5]. One of the best things about ginger is that it hasn't been linked to any serious or even common side effects [19]. Most traditional and complementary systems of medicine such as Ayurveda, Siddha, Unani, Homeopathy, Tibetan, Chinese, etc. prescribe *Z. officinale* individually or as a combination in both infective and non-communicable diseases. The plant is mostly investigated for antimicrobial, anticancer, antioxidant, antidiabetic, nephroprotective, hepato-protective, larvicidal, analgesic, anti-inflammatory, and immunomodulatory activities [20]. Its different names are mentioned in Table1.

2.2 Taxonomy [2,3,4,7,9,17,21-24,30-37]

Kingdom: Plantae
Scientific Name: *Zingiber officinale* Rosc.
Synonyms: *Zonth, Zanjibil*
Family: Zingiberaceae
Genus: *Zingiber*
Species: *Z. officinale*

2.3 Parts Used

The medicinal part of ginger is a rhizome (raw as well as dry) [23,27-30,34,38]

2.4 *Mijāz* (Temperament)

It was *haar* (hot), according to Dioscorides [10]. *Haar* (hot) in third-degree and *Yabis* (dry) in the second degree [1,27,29,39,40-42]. The ones that have been dried and roasted are considered warm and hot [34], *Haar* $(hot)_2$ *Yabis* $(dry)_2$ [43].

2.5 Botanical Description

The scraped rhizome occurs in sympodially branched pieces known as 'hands' or 'races'. These are 7-15 cm long, 1-1.5 cm broad, and laterally compressed. The branches arise obliquely from the rhizome and are about 1-3 cm long and terminate in depressed scars or undeveloped buds. The outer surface shows no sign of cork, breaks with a short fracture, has an agreeable aromatic odor, and has a pungent taste [7,30]. Leaves are narrow, linear-lanceolate 1.2 cm wide [1]. Flowers grow in spikes, greenish-yellow with a small dark purple or purplish-black tip [8]. The calyx is short, three-lobed [44]. The rhizome that has not been scraped is less coated by brownish cork layers with prominent ridges; the cork rapidly exfoliates from the lateral surfaces but remains between the branches. The powder is yellowish-white[30]. The gingerols, an oily liquid made up of homologous phenols are responsible for the pungency of fresh ginger. whereas the pungency of dry ginger mainly results from shogaols [3,7]. Dried ginger is prepared from mature rhizomes with a rich scent, flavor, and pungency. Dry ginger is pulverized to a mesh size of 50–60 to make ginger powder [9].

2.5.1 Geographical Distribution (Habitat)

Z. officinale, a reed-like plant, is grown in many tropical countries, including India (Cochin, Calicut, and Bengal), Jamaica, China, Africa, East Indies, Australia, and Florida [7,38,45].

Table No. 1. Name of *Zingiber officinale* in different languages [1,2,8,10,16,21-29]

S. No	Language	Name	S. No	Language	Name
1.	Arabic	*Zanjabeel*	2.	Kannada	*Hasisunth, Ardraka,Sunthi*
3.	English	Ginger	4.	Marathi	*Ale*
5.	Hindi	*Adrak* (fresh), *Sonth* (dry)	6.	Tamil	*Allam, inji*
7.	Bengali	*Ada*	8.	Malyalam	*Andrakam, Inchi*
9.	Gujarati	Sunth, Sundh	10.	Greece	*Zingiber*
11.	Persian	Sahangrez, Zanjabil	12.	Urdu	Sonth, Zanjabeel
13.	Sanskrit	*Ardraka, Ausadha*	14.	Telgu	*Allamu, Sonthi*
15.	Latin	*Zinziberi*	16.	Unani	*Zanjebeel, Sonth*
17.	Punjabi	Adrak, Sonth	18.	Kashmiri	Sho-ont

2.5.2 Propagation

By rhizomes [38].

2.5.3 *Af'āl* (Actions)

Analgesic, antidote, antiviral, detoxicant [31,46], Rheumatism, bronchitis, phthisis, postnatal complaints, anti-emetic, antidiabetic, diaphoretic, expectorant, antiulcer, carminative, stimulant, anti-inflammatory, antiplatelet aggregation, antibacterial, antifungal [7,35], rubefacient [11,30], strong diuretic [25], anesthetic, anti-inflammatory, anti-osteoarthritic, immunomodulatory, smooth muscle relaxant [44], vitiated conditions of *Vata* and *Kapha* [38], *Mujaffif* (desiccant) [42], emollient, anodyne [24], *Musakkin* (calorific), *Mulayyin* (laxative) [29]. Ginger is a powerful antioxidant that can either reduce or prevent the formation of free radicals [3,34,37]. In Arabian medicine, ginger is considered an aphrodisiac [14]. Ginger can also help with stomach and chest pain, as well as toothaches [47] .

2.5.4 *Isti'mālāt* (Therapeutic Uses)

Inflammation and rheumatism are treated with ginger in the *Ayurvedic* and *Unani* systems of medicine [36,48]. Used in pain, lumbago, headache, arthritis, sprains, muscular aches [1,3,25,46], ascites, and dropsy [25]. In *Unani* medicine dry ginger is listed as a medicine to treat cancer by *Al-Razi*. It is also used to treat fever, improves memory quotient, increases memory span, and learning ability [41,42,45]. *Jalinoos* recommended it in paralysis and all complaints arising from *Akhlat-e-Barida* (cold humour) [10]. Used in *Dard-e-Pusht* (Backache), beneficial for phlegmatic temperament [29,40,43]. Ginger has traditionally been used to treat chronic low back pain (CLBP). Ginger, both orally and topically, appears to be useful in the treatment of pain. The topical application of ginger appears to offer potential as a short-term treatment for knee discomfort [36]. In traditional Chinese medicine, ginger is used to improve the flow of body fluids [9]. As an external or local application, it acts favorably, as a stimulant and rubefacient [30]. Dried ginger is quite hot and produces warmth, useful for countering the poisonous effects of insects [39]. Its paste is useful in painful joints, phlegmatic, and serous swellings [29]. In the *Nighantas*, it is described as acrid and digestive, useful for removal of cold humour [10]. Ginger powder is as effective as ibuprofen [12]. In Brazil ginger is used externally for rheumatism. In Indonesia, it is externally used in the form of a poultice for swelling of rheumatic areas [44]. Many studies had shown that ginger is effective as a natural pain reliever and an anti-inflammatory agent in rheumatoid arthritis and osteoarthritis [33]. Ginger compress is effective in non-specific low back pain relief as ginger has an analgesic and anti-inflammatory effect on musculoskeletal pain [33].

2.5.5 *Muḍirrāt* (Side Effects)

Iniquitous for throat diseases [29,43]

2.5.6 *Mushilāt* (Correctives)

Roghan-e-badam (Almond oil), *Shehad Khalis* (Pure Honey) [29,43]

2.5.7 *Badal* (Substitute)

Dar filfil (*Piper longum* Linn.) [43], *Aqarqarha* (*Anacyclus pyrethrum* Linn.) [29,39]

2.5.8 *Miqdār-i-Khūrāk* (Dosage)

3-10 g fresh ginger or 2-4 g dry ginger 1-3 times/day [46], 1-2 g [28,26] , 7 g [29]

2.6 Compound Drug

Habbe-e-Shifa, Jawarish-e-Bisbasa, Jawarish-e-Jalinoos, Jawarish-e-Zanjabeel, Majoon-e-Flasifa, Sufoof-e-Hazim [26]

2.7 Chemical Constituents

Zingiberene, shogaol, gingerol, zingiberone, zingiberol, α-zingiberene, β-sesquiphellandrene, bisabolene, curcumene, 1-2% volatile oil, 5-10% resinous matter, starch and mucilage, monoterpenes, sesquiterpene hydrocarbons, zingerone, camphene, paradol [2,3,7,10,22,23,26,28,31,34,35,45,49]. Dried ginger has the following chemical composition: 40-60% starch, 10% proteins, 10% fats, 5% fibers, 6% inorganic material, 10% residual moisture, and l-4% essential oil (oleoresin) [48]. Beta-carotene, capsaicin, caffeic acid, curcumin, and salicylate [4]. The main chemical constituents are shown in Fig. 1.

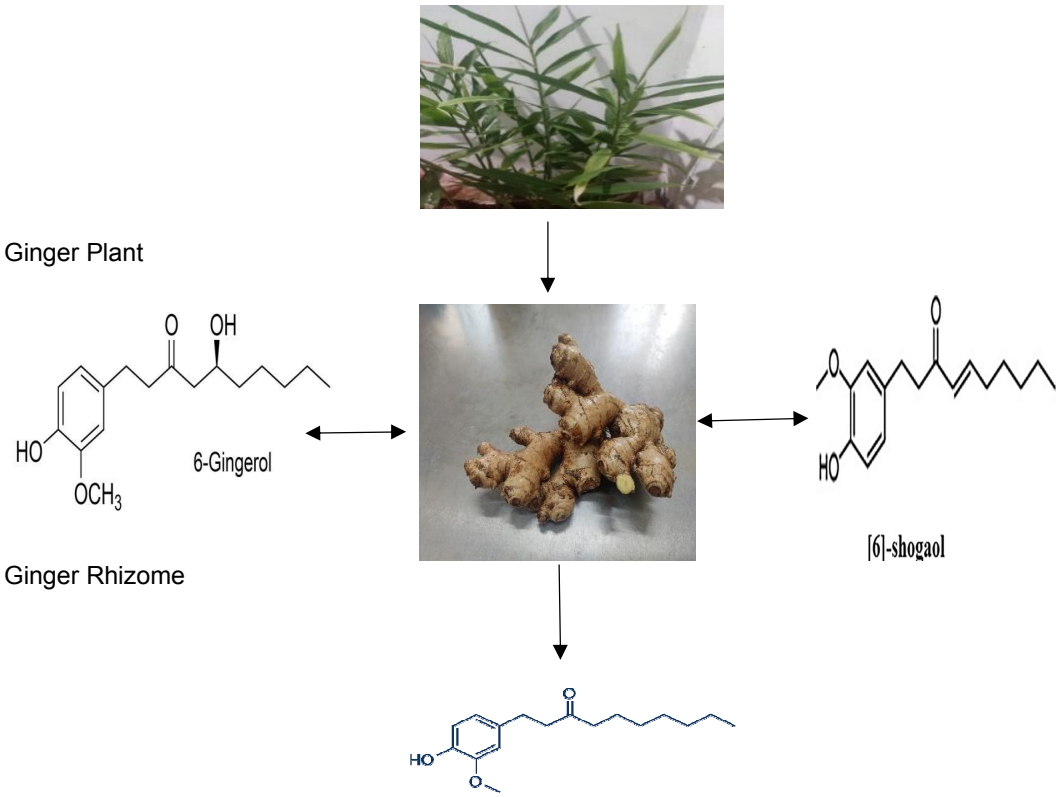

Fig. 1. Zanjabeel (*Zingiber officinale*) and its Bioactive Components

3. DISCUSSION

Zingiber officinale, commonly known as ginger, has a long tradition of medicinal use as an anti-inflammatory agent for musculoskeletal diseases in Ayurvedic and Chinese medicine for more than 2500 years [12,33,34]. In *Unani* medicine dry ginger is listed as a medicine to treat cancer by *Al-Razi* [41,42]. Galen recommended it in paralysis and all complaints arising from cold humour [10]. Ginger's anti-inflammatory properties were originally documented in the early 1980s, as indicated by its inhibitory effects on prostaglandin synthesis [3]. In vitro studies and several animal, trials provide evidence that ginger can ameliorate symptoms of inflammation-associated conditions such as arthritis [15]. Several of its chemical constituents, including gingerols, shogaols, paradols, zingerone, diarylheptanoids, and dialdehydediterpenes inhibit inflammatory prostaglandins. These compounds are dual eicosanoid production inhibitors, which makes them even more intriguing in the field of rheumatology [4,5,18]. Ginger extract has been shown to reduce joint swelling as well as relieve pain [37]. Methanol extracts of ginger, hexane, and ethyl acetate have the potential to inhibit key enzymes involved in inflammation such as cyclooxygenase (COX). Ginger also suppresses prostaglandin synthesis through inhibition of COX-1 and COX-2 and leukotriene biosynthesis by inhibiting 5-lipoxygenase. The activation of various genes involved in encoding inflammatory response proteins such as cytokines and chemokines is also inhibited by ginger extract, demonstrating that ginger modifies biochemical pathways that are activated by chronic inflammation [15,16,18,20,50]. Gingerols inhibit the production of inflammatory mediators such as nitric oxide, prostaglandin E2 (PGE2), Tumour Necrosis Factor alpha (TNF-α), and Interleukin beta (IL-β) [6,15,49]. In mice, acetone extract of ginger had a dose-dependent topical anti-inflammatory effect, regardless of the concentration of gingerol in the extract. In rats, a daily dose of ginger of

200 mg/kg body weight significantly reduced the incidence and severity of adjuvant-induced arthritis [15]. Haghighi *et al*., (2005) reported that in patients with osteoarthritis, the ginger extract could be utilized as an alternative to Non-steroidal anti-inflammatory drugs (NSAIDs) and as a supplement [5].

Experimental studies demonstrate that Ginger inhibits the synthesis of the pro-inflammatory mediators, prostaglandin and nitric oxide in porcine chondrocytes, and Leukotriene *in vitro*, which in clinical terms, could result in a reduction in the level of pain, and inflammation [3,51]. Ginger has a pain-relieving effect and can control pain via a variety of pathways, including prostaglandin suppression via the (cyclooxygenase) COX and (lipoxygenase) LOX pathways, antioxidant action, inhibition of the transcription factor (nuclear factor kappa-light-chain-enhancer of activated B cells) nf–kB, or acting as a vanilloid nociceptor agonist [36,49,50,52]. In addition to its potential to act at peripheral sites, ginger may also act centrally [52]. Gingerols, shogaols, and zingerone are thought to play a role in nociception and pain processing [31]. A study conducted by Lem and Lee, (2017) showed that that ginger compress is effective in pain relief and reduces functional disability in patients with non-specific low back pain [33]. A Randomized, double‐blind clinical trial conducted by Rayati *et al*., (2017) concluded that ginger powder is as effective as ibuprofen in the management of postsurgical sequelae [12]. A randomized, controlled trial conducted by Rahnama *et al*., (2012) showed a significant effect of ginger on pain relief in primary dysmenorrhea [53]. Chen *et al*., (2016) reported that oral ginger could be an effective treatment for menstrual pain in dysmenorrhea [54]. According to one comprehensive analysis, ginger has a better safety profile than NSAIDs as a pain reliever, with fewer gastrointestinal side effects and renal concerns. According to Black *et al*., (2010) heat-treated ginger resulted in a 23% reduction (8.6 VAS units) in muscle-pain intensity [31]. Heat treatment of ginger has been suggested as a way to boost its anti-inflammatory properties. Heating ginger could lead to greater analgesia. Oral and topical usage of ginger seems to be beneficial against pain, according to eight randomized clinical trials [36]. Krvachenko *et al*., (2019) reported that *Zingiber officinale* dense extract possesses significant antinociceptive action after its transdermal delivery. The essential oil of ginger has also been used topically as an analgesic [47]. Maghbooli *et al*., (2013) showed that the use of 250mg of ginger powder during migraine attacks was as effective as 50 mg of sumatriptan in relieving pain intensity 2 h after ginger intake [19]. Menon *et al*., (2021) reported that dried ginger powder is as effective as Ibuprofen in controlling pain and gingival inflammation that arises after open flap debridement. Ginger is used in alleviating headaches and has been shown to help with pain relief [50].

Ginger is a natural anti-oxidant and extracts of ginger have pronounced antioxidant activity [9,14,16,20,48,49,55]. Phenolic compounds are the primary source of antioxidant action in plants. Ginger has an antioxidant effect as of having polyphenol content [6]. Because of the presence of its alpha, beta-unsaturated ketone moiety, Shogaol was shown to have the most strong antioxidant and anti-inflammatory properties [16]. The antioxidant is significant in preventing certain diseases, it slowdowns the aging process [6]. It is reported that ginger inhibits Epstein-Barr virus infection and thereby prevents cancer [14]. Ginger essential oil is known as an immunomodulatory agent that exhibits antioxidant activity, and 12.1-80.53% radical scavenging activity [34]. *Zingiber officinale* active ingredients like [6]-gingerols, shogaols, zingerone, and so on exhibit antioxidant activity [3,36]. The oil of ginger has a protective effect on Deoxyribonucleic acid (DNA) damage [50].

Due to phenolic compounds, ginger has shown excellent antimicrobial properties and is effective in controlling viruses, bacteria, fungal diseases, etc [50]. The antimicrobial properties are due to the presence of components such as thymol, eugenol, 1, 8- cineole, α- and β-pinenes, linalool, and α-terpineol [16]. Parabens and their salts are used primarily for their bacteriocidal and fungicidal properties [3,34]. Ginger extracts and individual constituents like gingerols and phenolic metabolites have been reported in in-vitro studies to suppress the growth of a variety of common infectious bacteria including Staphylococcus aureus and Listeria monocytogenes [18].

4. CONCLUSION

Ginger is an important herb that exhibits many medicinal and ethnomedicinal properties. Most traditional and complementary systems of medicine such as Ayurveda, Siddha, Unani, Homeopathy, Tibetan, Chinese, etc. prescribe *Z. officinale* individually or as a combination in both infective and non-communicable diseases. *Unani*

physicians used ginger for the treatment of inflammation and rheumatism. It is apparent from the data that ginger and its bioactive constituents possess multiple biological activities that suggest potential benefits for alleviating a variety of health problems. Ginger's therapeutic benefits are due to several bioactive components. The principal bioactive components in ginger are gingerols, the most common of which is 6-gingerol. In vivo and in vitro studies recently conducted have shown that ginger has tremendous promise due to its analgesic, anti-inflammatory, antibacterial, and antioxidant properties, as discussed in this article. However, the majority of these pharmacological effects of ginger must be validated through comprehensive clinical research that can support ginger's pharmacological usefulness and chemical contents. In general, it's unknown what form and dosage of ginger are best for treating certain ailments. Overall, based on present scientific evidence, ginger appears to have some promising health benefits, and more data from other clinical research will help confirm whether ginger's various health benefits can be realized in humans. At this time, it's uncertain whether the culinary use of ginger may be expected to deliver the health advantages substantially mentioned in this summary. More research on the kinetics of ginger and its constituents in animals and humans, as well as the consequences of long-term ingestion, is needed. Ginger is thought to be a relatively safe herbal treatment with few and minor negative effects. More human trials are needed to determine the efficacy of ginger (or one or more of its components) and to evaluate what, if any, side effects are seen.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

NOTE

The study highlights the efficacy of Zanjabeel (*Zingiber officinale* Roscoe.) in *Unani* system of medicine. The *Unani* system of medicine is an ancient tradition, used worldwide. This ancient tradition should be carefully evaluated in the light of modern medical science and can be utilized if found suitable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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