INTRODUCTION

Duranta repens Linn. (D. repens) belonging to family Verbenaceae is native to clean and open forests. It is used as an ornamental plant in tropical nations [1,2]. The genus Duranta was described by Linnaeus (1753). This genus is named after Castor Durante (1529–1590), a French physician and botanist [3]. The plants of Verbenaceae family are herbs, shrubs, or trees comprising about 100 genera and 2,600 species. Around 35 Duranta species with evergreen bushes are spread over tropical and subtropical areas. D. repens was used in Egypt as an ornamental plant [4]. D. repens (Golden dewdrop) otherwise called sky blossom, angels-whisper, additionally called Katamehedi. Duranta is an upright to hanging bush that occasionally takes the type of a scrambling bush or once in a while a little tree [5,6]. They mostly occur in tropical and subtropical and few temperate regions. Habit varies from tree lianas to shrubs and herbs. Leaves are simple, opposite or alternate arranged, entire or divided, and exstipulate. Flowers are often involucres of colored bracts. Plants are sometimes thorny. Fruits are fleshy drupes, usually 1-seeded, completely enclosed by the persistent calyx. Fruits are less commonly capsular or schizocarps. Seeds show a presence of oily embryo with little or absence of endosperm. The economic uses include as sources of timbers, essential oils, teas, accidental medicines, fruits, gums, tannins, and ornamentals. Flowers are small mostly blue–purple, or white bracteates with racemes are either terminal or axillary. Calyx tube subcampanulates ribbed and toothed. Corolla tube is cylindrical straight or apically curved and pubescent at the mouth. An Ovary is 4-carpelled with 8 locules, one ovule in each lobule, style terminal with unequally 4-lobed stigma [7,8].

Conclusion: Considering these facts, I endeavored to present a comprehensive review enlightening the phytochemistry and pharmacological activities of plant D. repens. Future research can be directed to an extensive investigation about phytochemistry, clinical trials, pharmacokinetics, and acquiring safety data so as to add new dimensions to the therapeutic utilization of D. repens and other Duranta species.

Keywords: Duranta repens, Verbenaceae, Microscopical characters, Phytochemicals.

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ABSTRACT

Objective: This review is intended to investigate the published report regarding phytochemical, ethnomedicinal, and pharmacological activities and put forth the therapeutic potential of Duranta repens Linn. (D. repens). It belongs to the family Verbenaceae, one of the therapeutically important plants, broadly distributed all throughout the world. It is commonly referred as golden dewdrop, angel whisper, pigeon berry, or skyflower.

Methods: I utilized logical writing and scientific literature regarding D. repens by referring search engine such as Springerlink, ScienceDirect, SciFinder, PubMed, Scopus, Google Scholar, and BioMed Central as well as relevant books, websites, scientific publications, and dissertations as a source of information that provided an up-to-date review. My work on morphology and extraction of various phytochemicals and their evaluation has helped to provide an insightful account of D. repens.

Results: Phytochemical profiling of these species revealed the presence of some imperative phytochemicals such as alkaloids, flavonoids, glycosides, phenolics, saponins, steroids, tannins and terpenoids as the basis of its valuable therapeutic properties. The other imperative phytoconstituents which contribute to the therapeutic properties are durantol, repennoside, repenins, and scutellarein. The pharmacological activities exhibited by D. repens as antimicrobial, antioxidant, and insecticide properties are attributed to the presence of valuable bioactive phytoconstituents.

Introduction to D. repens

Taxonomical classification [9,10]
Domain: Eukaryota
Kingdom: Plantae
Subkingdom: Tracheobionta (Vascular plants)
Phylum: Spermatophyta
Subphylum: Angiospermae
Class: Dicotyledonous
Subclass: Asteridae
Order: Lamiales
Family: Verbenaceae (the Vervain family)
Genus: Duranta
Species: Duranta repens
Common Name: Golden Dewdrop

Vernacular names[11]
English: Golden dewdrop, pigeonberry, and skyflower
Kannada: Neelakantha
Marathi: Piwali Mendi
French: Vanillier de Cayenne
Indonesian: Sinyo nakal
Japanese: Taiwan-rengyô
Tongan: Mavaetangi
Vietnamese: Thanh qua
South Africa: Goelbessi
GEOGRAPHIC DISTRIBUTION OF D. REPENS
Golden dewdrop grows wild mostly in a dry coastal area from near sea level to over 100 m in elevation. It grows in areas with moister habitat, and especially, along roads. Golden dewdrop is native to Mexico, Central America, South America Argentina, Southern Florida (possibly naturalized), Bermuda, the Bahamas, and the West Indies. The species is widely cultivated in tropical and subtropical regions which includes Hawaii, American Samoa, and Guam. It is extensively cultivated throughout India along the sides of rivers and banks of streams. It grows on rocky slopes and mostly found sometimes along roadsides in villages [12-16]. Golden dewdrop forms a part of the coastal scrub community and contributes to soil and ecosystem stability. It is a commonly grown plant when trimmed forms a strong, compact hedge which is almost impenetrable to cattle. It is a popular ornamental plant used as an accent and planted in tropical and subtropical parts of the world because of its profuse displays of flowers [17].

TRADITIONAL USES OF D. REPENS
Traditional plants are an important source of a natural remedies and remain to be broadly used to treat many diseases [18]. An infusion of the leaf and juice of the fruit is diuretic, and flower is said to have stimulant properties. Both leaf and fruit give a positive test for hydrocyanic acid. In the Chinese system of medicine, fruits are mentioned as poisonous berries. The plant is claimed to treat malaria which still stands as a major disease in the developing countries. Water-macerated fruits yield a juice which even in dilutions of 1:100 parts of water are lethal to mosquito larvae; the action is less marked on culicine larvae. The juice can be used as larvicide in ponds and swamps. Fruit contains an alkaloid analogous to narcotine while leaf contains saponins. Some glycosides are also reported from the bark of the plant. In Chinese medicine, the fruits were used for the treatment of malaria, and the leaves are employed for the treatment of abscesses [19]. The fruit is said to cause illness and death in children. The symptoms imply sleepiness, high temperature, dilated pupil, rapid pubes, swelling lips and eyelids, and convulsions [20]. The seeds yield oil with the following characteristics: Acid value (58.62%), saponification value (210.9), iodine value (101.3), and unsaponifiable matter (0.4%) [21]. The plant is believed to be poisoning the livestock and is said to be very bitter hence not eaten by livestock [22].

CHARACTERISTICS OF THE PLANT D. REPENS
The shrub grows up to a 7 m with branches subquadrangular, drooping or trailing, spiny, and sparsely pubescent and turns glabrous with age. Terminal inflorescence is axillary with 10–30 cm long and racemed or canescent outside. It is glabrous inside with 5-angled tube and is 6–10 mm long and 1.5–2 mm diameter. Stamens inserted above the middle of the corolla-tube are filaments with 0.5–1.5 mm long and 6–10 mm long and ±1 mm wide. Anthers are oblong and ±1 mm wide. Ovary is subglabrous glabrescent with style 2–3 mm long stigma is minutely capitate and 4-lobed. Fruit is orange–yellow with subglobose or obpyriform and glabrous completely enclosed by the accrescent orange–yellow shiny calyx. Macroscopical characters of the leaves as shown in Fig. 2 demonstrate a dark green color on both surfaces seen as deciduous; leaf base is decurrent symmetrical petiolated.

The composition of the lamina is simple, pinnate reticulate venation, entire margin, acuminate apex, sub-ribbs alternate, surface glabrous, and texture subcoriaceous. The size of leaves varies from 1.5 to 4.6 cm in length and 2.4 cm in breadth [23]. D. repens shows several stems or drooping spiny branches, especially when carrying a large number of fruit. The bark is light grey, becoming rough, and fissured when old. There are usually at least some pairs of spines along the stems, one located at the base of each of the leaf stalks [24].

BIOLOGICAL AND PHARMACOLOGICAL ACTIVITIES
Natural products have been playing a substantial part throughout the world in treating and averting human diseases [25]. Literature proposes that D. repens L. has been accounted for a wide variety of medicinal activities. The whole plant is used in the treatment of infertility, pneumonia, and malaria, as diuretic, itches, antihelmintic, neuralgic disorders and also as an insect repellent. D. repens also exhibits activities such as anti-shigellosis, cytotoxic potency, antiviral activity, antioxidants, antibacterial, and antimicrobial against human pathogens [24-29] (Table 1).

Table 1: Biological activities of D. repens

| Sr. No | Activity reported | Reference |
|--------|-------------------|-----------|
| 1      | Thrombin inhibitory | [30,31]  |
| 2      | Mosquitocidal      | [41]      |
| 3      | Antiviral          | [33]      |
| 4      | Cytotoxicity       | [32]      |
| 5      | Antioxidant        | [45-47]   |
| 6      | Antiplasmodial     | [39]      |
| 7      | Anti-shigellosis   | [34]      |
| 8      | Antifungal         | [37,38]   |
| 9      | Antimicrobial      | [34-36]   |
| 10     | Insecticidal Property | [42-44]   |

D. repens: Duranta repens
Thrombin Inhibitory Activity

Anis et al. reported isolation and evaluation of isoprenylated flavonoids, tri-methoxyflavone, isoprenylated acetophenone, and other derivatives for thrombin inhibitory activity. Results concluded inhibitory activity against propyl endopeptidase active against thrombin [30]. Anis et al. isolated C-alkylated flavonoids, trans-clerodane diterpenoids, and other constituents from D. repens. The known flavonoid was reported for the first time from this species. This flavonoids showed significant thrombin inhibitory activity [31].

Cytotoxic activity

Ahmed et al. isolated two new triterpene saponins and ten known compounds and screened for cytotoxic activity on brine shrimps. The investigated methanol extract and compounds, durantin, known as compound 2 and 7 showed significant cytotoxic activity against a HepG2 cell line [32].

Antiviral activity

Abou-Setta et al. reported antiviral activity of the ethanolic extract of D. repens against hepatitis A virus. Results showed 76% reduction in viral titer of hepatitis A with ethanolic extract at the concentration of 40 µg/mL, while at 20 µg/mL, the inhibition reached 64% determined by plaque reduction assay. The methanolic extract showed 88% inhibition at the concentration of 40 µg/mL, while at 20 µg/mL, the inhibition reached 59% of the virus by the same assay. They suggested that this antiviral activity may be attributed to the acetosides or lamiide content of the extract [33].

Antimicrobial activity

Nikkon et al. reported extraction, fractionation, and isolation of two triterpenes (β-Amyrin and 12-Oleanene) from the chloroform-soluble fraction of an ethanolic extract and also determined minimum inhibitory concentrations (MIC) of the ethanolic extract of D. repens stem, which were evaluated for antibacterial and antifungal activities by the disc diffusion method and cytotoxicity by brine shrimp lethality bioassay. The MICs of the extracts (stem and fruits), their fractions, and compound 1 were found to be in the range of 32~128 µg/ml [34]. Ogbuagu et al. evaluated the antibacterial activity of methanolic extract obtained from Nigerian D. repenes leaves against some human pathogenic bacteria: Proteus mirabilis, Bacillus subtilis, Salmonella typhi, and Boletus aereus at 75, 150, 300, and 600 mg/mL by the agar diffusion method. The result of MIC determined showed significant activities against the growth of P. mirabilis (141 mg/mL), S. typhi (81 mg/mL), and B. aereus (100 mg/mL) [35]. Jayalakshmi et al. reported the antibacterial activity of various solvent extracts of medicinal plants against the human pathogenic bacteria such as Escherichia coli, Klebsiella pneumoniae, B. subtilis, Bacillus cereus, S. typhi, E. aerogenes, and S. aureus by agar cup diffusion method. Methanol extracts of D. repens L. showed significant antibacterial activity. The antibacterial activity of plant extract is promising as compared to standard drugs streptomycin and gentamicin [36].
Antifungal activity
Sharma et al. reported the antifungal properties of the methanolic extract of different parts such as leaves, stem, and roots of D. repenes against Aspergillus niger, Aspergillus flavus, Aspergillus umigatus, and Penicillium sp. using agar disc diffusion method. They reported that methanolic extract of leaf and stem of D. repenes was effective against A. niger, A. flavus, and A. fumigatus at 1000 mg/mL concentration which recorded significant inhibition zone of 2.3 cm, 2.3 cm, and 2.2 cm, respectively [37]. Silarwar et al. investigated the antifungal activity of aqueous and methanolic leaf extracts of D. repenes against three fungi A. niger, C. albicans, and M. gypseum by disc diffusion method. The result showed promising antifungal activity against the tested fungi. Antifungal activity of the test extracts at different inhibitory concentration varied significantly (0.05 level of significance). Where methanolic extract proved to be effective compared to the aqueous one [38].

Antiparasitic activity
Ijaz et al. reported that D. repens from Pakistan showed antiplasmodial activity against the chloroquine-sensitive and chloroquine-resistant strains of Plasmodium falciparum, with IC50 values of 8.5±0.9 and 10.2±1.5 μg/mL, respectively [39].

Insecticidal property
El-Naggar and Mosallam evaluated that extracts from D. repens had antifeedant and insecticidal properties against the larvae of Culex pipiens and Spodoptera littoralis and the adults of Musca domestica [40]. Nikkon et al. reported larvicidal activity of crude extracts from the stem and fruits, and their fractions and fresh fruit juice of D. repens were assayed against the larvae of Culex quinquefasciatus. The highest larval mortality was found in chloroform-soluble fraction of the stem, with 12 h-IC50 being 10.75 ppm, and in ethanolic extract of fruits, with 12 h-IC50 being 8.31 ppm against the first instar larvae. Various concentrations of fresh fruit juice showed potent effects on C. quinquefasciatus, and the larvae showed proportional tolerance with the increase of their age and time. These results suggest that the stem and fruits of D. repens are very effective natural larvicidal and can be useful against Culex quinquefasciatus [41]. McConnell et al. evaluated insecticidal property of the methanol and water extracts of D. repens Linn. leaves against larvae of C. quinquefasciatus (Say). Here, both the extracts of D. erecta have larvicidal activity [42]. Hemavathy et al. reported larvicidal activity of the aqueous and methanolic extracts of D. repens leaves from India against larvae of C. quinquefasciatus that showed the high percentage of mortality compared to ethanolic extract. At 10% concentration of the extract of water, methanol, and ethanol, the larvae found to be dead were 17, 16, and 13 of 20 larvae [43]. Roy et al. evaluated an aqueous extract of D. repens leaves from India against the feared spider mite (Oligonychus coffeae) to determine its effect on adult mortality, the viability of eggs, oviposition deterrence, and repellent properties. The direct spray method was used at concentrations of 2, 4, 6, 8, and 10 g/L. Deposition of eggs by adult mites on treated leaf surfaces decreased, and the viability of eggs was also reduced. Its efficacy was comparable to that of the commonly used commercial neem oil azadirachtin formulation. In addition, in the field, the application of the aqueous extract of D. repens reduced the mite population, and its efficacy was comparable to that of the synthetic pesticide propargite [44].

Antioxidant activity
Ahmad et al. reported phytochemical investigations on the chloroform-soluble fraction of the whole plant of D. repens Linn. They isolated four new coumarinolignoids: Repenins, coumarinolignoids, cleomisin, and durantin. The compounds showed significant radical scavenging activity against 2,2-diphenyl-1-picrylhydrazyl-hydrate (DPPH) radicals, with IC50 values in the range 0.420–0.625 mM. Repenins displayed the strongest scavenging potential with IC50 values of 0.420 mM [45]. Shahat et al. isolated three compounds from methanol extract of D. repens from Egypt, i.e., phenylethanoid glycoside, acetosides, iridoid lamide, and saponin pseudo-ginsenoside-R1. Acetosides showed an IC50 of 3.05 ± 0.09 μg/mL in the DPPH assay, while lamide and pseudo-ginsenoside-R1 were not active [46]. Khan et al. investigated ethanol and methanol extracts of D. repenses fruits for the antioxidant potential that can protect H2O2-induced oxidative cell damage. HEK293T cells were treated with different concentrations (0–1000 μg/mL) of ethanol extract and methanol extract of D. repens for 24 h and then treated with 100 μM H2O2 for 24 h. They determined cell viability and antioxidant constituent of the extracts. Treatment with a limited dose of both extracts increased the survival rate of H2O2-treated HEK293T cells; however, the extra-high dose showed growth inhibitory effect. The results showed treatment with both extracts protected cellular lipid peroxidation. In vitro analysis showed that ethanol and methanol extracts increased the survival rate of H2O2-treated HEK293T cells, lipid peroxidation, 2, 2-diphenyl-1-picrylhydrazyl, and H2O2 scavenging activities. A limited dose of ethanol and methanol extracts possesses antioxidant potential, which can protect H2O2-induced oxidative cell damage [47].

Phytochemical composition
Literature proposes that D. repens L contains a wide array of various bioactive compounds. Interestingly almost all parts of the D. repens species have been exploited for phytochemical investigation, and various phytoconstituents are isolated till date. Various important phytoconstituents have been reported such as C-alkylated flavonoids, steroids, flavonoids, terpenoids, triterpenes, beta-sitosterol, naringenin, triterpenes saponins, steroidal glycosides, and glycosides as shown in Fig. 3. From Duranta genus, several iridoid glycosides as durantosides are isolated. The leaves contain a saponin, and fruits contain alkaloid analogous to narcotine [48]. Itrat et al. 2001 reported the two C-alkylated flavonoids, two C-tropane type of triterpenes, and flavonoid as 3,5,4’trihydroxy-6,7-dimethoxyflavone [49]. Ahmed et al. from the chloroform fraction of D. repens isolated 24-ethyl-25-hydroxycholest-23(24)-diene-3-one steroid [50]. Harbome et al. reported a 5,6,7-trihydroxy-4’-methoxy-flavone [51]. Kuo et al. described a new iridoid, durantoside-IV pentaacetate from the leaves of D. repens. The same authors, working on the leaves of this plant, recently reported oleanolic and ursolic acids and from the hexane extract β-sitosterol glucosides. From the acetone extract, they have also reported inorganic salts from the water-soluble portion of ethanolic extract and E-cinnamic acid, and (E)-p-methoxycinnamic acid and a fraction containing a strongly bitter substance were isolated from the ethyl acetate soluble fraction of the ethanolic extract. The fraction containing bitter substances was later found to comprise glucose pentacetate, kusagin non-acetate, and verbascoside [52-56]. Hiradate et al. reported three triterpenoid saponins, durantanin-I, II, and III, respectively, from the leaves of D. repens which are the plant growth inhibitors. Durantoside-I pentaacetate, durantoside-I tetraacetate, durantoside-II tetraacetate, durantoside-IV pentacetate, and durantoside-V tetraacetate were also isolated from D. repens [57,58]. Rimpler and Tinn reported the presence of three iridoid glucosides as durantoside-I, II, and III [59]. Rao et al. reported durantoside-IV [60]. Other constituents reported were (+)-Hardwickic acid [61], (+)-3,13-Clerodadien-16,15-olid-18-oic acid [62], betulin [63], stigmasteryl [64], stigmasterol 3-0, 8-D-glucopyranoside [65], and scutellarein and pectolinarigenin [66].

CONCLUSION
Based on the existing review of literature, D. repens reveals its valuable therapeutic use as antimicrobial, antifungal, antiviral, and antimalarial and in other parasite infestation. It has a potent free radical scavenging activity which sufficiently demonstrated in different experimental and clinical studies. Its potential as an antioxidant and cytoprotective agent needs to be undermined in future research work. Various unique molecules of D. repens can also be chemically modified or used as “lead” for developing more effective drug molecules. Therefore, extensive pharmacological and phytochemical analysis, experiments, together with pharmacokinetic and toxicological studies will be a focus for
forthcoming investigation. Furthermore, a well-designed study to measure its toxicity from its long-term use is another urgency. This review article emphasizes the potential of *D. repens* that can be employed in new therapeutic drugs and will offer the base for future research on the application of herbal medicines.

**AUTHORS' CONTRIBUTION**

Abhishek Puri: Concept of paper, compiling full literature, the inscription of a manuscript, revising, the read-through of the manuscript, and contributed to improve the standard of the manuscript.

**CONFLICTS OF INTEREST**

The authors declare that he has no conflicts of interest.

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