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Ocimum Tenuiflorum Linne: A Narrative Review

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ABSTRACT

Indonesia's diverse flora offers significant potential for medicinal plant production, yet reliance on anecdotal experiences prompts a deeper examination. This study focuses on Ruku-ruku (Ocimum Tenuiflorum Linne), traditionally a culinary herb in West Sumatra. Despite its local culinary use, Ruku-ruku remains largely unexplored for medicinal properties, emphasizing the importance of phytochemical screening to uncover its therapeutic potential. Ocimum Sanctum, known as Holy Basil or Tulsi, holds sacred status in India and boasts a rich history documented in ancient medical texts. This study aimed to review the evidence for therapeutic efficacy and botanical and chemical aspects. The research methodology, employing a narrative literature review, assesses 40 studies (2015-2023). Results underscore Tulsi's holistic benefits, covering metabolic disorders, cardiovascular and cognitive health, infections, cancer prevention, oral health, wound healing, and weight management. Diverse formulations, from essential oils to capsules and gels, highlight the extensive applications of Ocimum Tenuiflorum Linne. The study explores botanical and chemical aspects, including shoot induction and essential oil extraction. Ocimum Sanctum's adaptogenic and antimicrobial properties are discussed, showcasing its potential under stress conditions and against various infections. In conclusion, this review stresses the vast therapeutic potential of Ocimum Tenuiflorum Linne, urging further research to unlock its full medicinal benefits. Integrating traditional wisdom with modern science positions these plants as valuable subjects for pharmaceutical and medicinal applications, potentially addressing contemporary health challenges, including the COVID-19 pandemic. This research contributes to providing information about Ocimum Tenuiflorum Linne and its benefits for health care as therapeutic properties.

Keywords: Ocimum Tenuiflorum Linne, Ocimum Sanctum, Therapeutic Properties, Health Care

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1. INTRODUCTION

Indonesia, with its rich diversity of natural products, holds immense potential to emerge as a major producer of medicinal plants. However, the current trend reveals that people often utilize various plants as natural remedies based solely on personal experiences, without a comprehensive understanding of their exact medicinal content. Interestingly, some plants with promising medicinal potential are only recognized for their culinary applications, such as Ruku-ruku (Ocimum Tenuiflorum Linne). Ruku-ruku, a wild plant commonly found along roadsides, bears a morphological resemblance to basil (Ocimum sanctum). The leaves of Ruku-ruku, frequently utilized by local communities, are notably incorporated into processed fish dishes in West Sumatra. Ruku-ruku is a perennial shrub that grows upright and branches profusely. Commonly cultivated in gardens, home yards, fields, or along roadsides, this plant can reach a height of up to 100 cm (smaller than basil plants). In its youth, the stem is herbaceous, adorned with white hairs, and as it matures, it becomes woody. The leaves emit a distinctive aroma reminiscent of cloves, featuring blunt and pointed tips, reaching a length of up to 5 cm. The flowers, green or purplish in color, cluster together in an erect inflorescence. This culinary application is attributed to the distinctive aroma of Ruku-ruku leaves, known for its ability to mitigate the fishy odor in seafood. Despite its prevalent culinary use, Ruku-ruku holds untapped potential as a medicinal plant. The characteristic aroma of its leaves is believed to emanate from essential oils, which are secondary metabolites similar to those found in basil leaves. Exploring the secondary metabolites in Ruku-ruku leaves through phytochemical screening becomes crucial for identifying and understanding the bioactive compounds within. This preliminary qualitative test is essential to unlock the full potential of Ruku-ruku as a medicinal plant, paving the way for further investigations and maximizing its therapeutic functions (Parbuntari et al., 2019; Sulianti, 2008).

A standing, herbaceous or semi-woody plant, originally from India but widely distributed across the tropics. Revered as an eternal symbol, this sacred plant holds a special significance in Hinduism, embodying perfection and possessing the power to remedy ailments while guiding worshippers to heavenly realms. Referenced in ancient Indian medical texts like Charak Samhita and Susruta Samhita, this plant's every component serves medicinal purposes, with Charak identifying its efficacy in addressing Kapha and Vata imbalances (Akbar, 2020).

Ocimum Sanctum, commonly known as Ocimum Tenuiflorum or 'Holy Basil,' is a highly esteemed medicinal plant in India. Belonging to the Lamiaceae family, it is referred to as Thulasi (or Visnupriya) in Sanskrit, Thulasi in Tamil, and Tulasi in Hindi. Recognized in Āyurveda as a life-saving herb and hailed as 'the elixir of life,' this plant is indigenous to the Indian subcontinent, particularly North Central India, as indicated by phylogeographic studies using the trnL-trnF intergenic spacer of the plastid genome as a DNA barcode. Its geographical reach extends beyond India to include northern and eastern Africa, Taiwan, and Hainan Island. Holy basil thrives at altitudes of up to 5,900 feet (1,800 meters) in the Himalayas and is also found in various regions such as Myanmar, Philippines, Indonesia, Thailand, Malaysia, China, Cambodia, Vietnam, and Laos. The cultivation of Holy Basil is not limited to Southeast Asia; it is also abundantly grown in Australia, West Africa, and certain Arab countries. The widespread presence of this sacred plant reflects its profound cultural and medicinal significance across diverse regions (Shasany, 2016). Holy Basil (Ocimum Tenuiflorum), which is part of the Lamiaceae family, is well-known for its therapeutic benefits, including its anti-stress, anti-inflammatory, anti-diabetic, anti-carcinogenic, and protective impacts on the heart, nervous system, and liver (Bhavya et al., 2018; Rastogi et al., 2020).

According to literary evidence, the therapeutic use of Tulsi dates back to 400-500 BC, with the earliest references found in the Rigveda (3500-1600 BC). Tulsi has been employed for various health purposes, including its radioprotective, and fertility-enhancing properties, among others. As an adaptogen, Tulsi is utilized to enhance overall health. In Ayurvedic treatments, Tulsi extracts find applications in addressing common colds, stomach disorders, fever, heart diseases, poisoning cases, bronchitis, malaria, epilepsy, convulsions, and certain inflammatory issues. This is why Tulsi extract is often referred to as the "Extract of Life" and is believed to contribute to longevity (Bano et al., 2017).

Previous studies have provided evidence of the benefits of Ocimum Tenuiflorum through various experimental methods. The difference between previous studies and the novelty of this study is that a method with a narrative review is used to find information that earlier researchers have studied. This study aimed to review the evidence for therapeutic efficacy and botanical and chemical aspects.

2. METHOD

This study employs the Narrative Literature Review method and follows a descriptive approach. A thorough exploration of articles was conducted through manual searches on three databases—Google Scholar, ProQuest, and ClinicalKey—utilizing the keywords "Ocimum Tenuiflorum Linne" or "Ocimum Sanctum Linne." The electronic search encompasses data from 2015 to 2023. The selection process ensured that recently published articles adhered to predefined inclusion and exclusion criteria. The research's population and sample consist of all articles relevant to Ocimum Tenuiflorum Linne. After scrutinizing titles and abstracts, a literature search identified 40 studies that fulfilled the inclusion and exclusion criteria.

The following are the inclusion criteria: 1) Articles that are accessible in English. 2) Articles that were released in the years 2015–2023. 3) Articles that address Ocimum Tenuiflorum Linne in particular. The following are the exclusion requirements: 1) Full text not available. 2) Articles categorized as literature reviews or systematic literature reviews

3. RESULTS AND DISCUSSION

3.1. Results

Table 1 shows the results of a summary of the therapeutic properties of Ocimum Tenuiflorum Linne. Based on these results, we narrate the results of this study. Ocimum Tenuiflorum Linne, commonly known as Tulasi or Holy Basil, exhibits a diverse range of therapeutic properties as evident from various studies. The plant demonstrates significant antidiabetic and antihyperlipidemic effects, showcasing its potential in managing metabolic disorders. Additionally, its antidyslipidemic and cognition-enhancing properties highlight its role in promoting cardiovascular and cognitive health. Tulasi's antimicrobial activities, including anti-microbial, anti-inflammatory, and antifungal properties, make it a valuable resource in combating infections and inflammatory conditions. Moreover, its anti-cancer properties suggest a potential role in cancer prevention and treatment. The plant's antioxidant activities contribute to reducing oxidative stress, while its anti-stress and antipyretic activities further enhance its therapeutic potential. Tulasi's impact extends to oral health, as seen in its efficacy against oral candidiasis and gingivitis. Additionally, the plant exhibits antibacterial properties on wounds, emphasizing its potential for wound healing. The anti-overweight and anti-obese effects suggest a role in weight management. Furthermore, Tulasi demonstrates antiviral properties, making it a potential agent against viral infections. The plant's versatility is evident in its use as an insecticide and anesthesia, showcasing its wide-ranging applications. Overall, the cumulative findings underscore the holistic therapeutic benefits of Ocimum tenuiflorum Linne across various health conditions.

The therapeutic properties of Ocimum Tenuiflorum Linne have been investigated across various dosages and formulations, highlighting its diverse applications. Studies using doses of 125, 250, and 500 mg/kg demonstrate the plant's efficacy in different contexts, from antidiabetic and antihyperlipidemic effects to cognition enhancement. Essential oils (EOs) and ethanolic extracts at different concentrations, such as 0.125-32 µL/mL and 2.5%, 5%, and 10%, respectively, showcase the versatility of Ocimum Sanctum. Capsules and gels containing Ocimum Tenuiflorum extracts at concentrations ranging from 1% to 10% reveal potential applications in oral health and weight management.

The exploration of shoot induction with concentrations of BAP and the steam distillation process for essential oil extraction highlights the botanical and chemical aspects of therapeutic development. Chronic variable stress (CVS) studies involving Ocimum Sanctum leaf powder consumption at 4.45 g/kg/day showcase its adaptogenic properties under stress conditions. Additionally, the administration of NiGs, plant extracts, and eugenol at various concentrations demonstrates the plant's potential in combating microbial infections, including antifungal and antibacterial activities.

The diverse formulations, extraction methods, and concentrations further validate the broad range of therapeutic benefits associated with Ocimum Tenuiflorum Linne. Whether through oral extracts, capsules, gels, or steam distillation, the plant exhibits promising therapeutic properties across multiple dimensions, making it a valuable subject for continued research and exploration in pharmaceutical and medicinal applications.

The therapeutic properties of Ocimum Tenuiflorum Linne, commonly known as Tulsi or Holy Basil, have been extensively explored, revealing its diverse health benefits. The hydroalcoholic extract of Ocimum tenuiflorum demonstrates significant anti-diabetic and anti-hyperlipidemic activity, comparable to the effects of glibenclamide. Phytochemical screening identifies alkaloids, flavonoids, steroids, terpenoids, and saponins in the plant, indicating a rich chemical composition.

Ocimum Sanctum, another variant of the plant, showcases antidyslipidemic and antioxidant activities, making it a potential preventive measure against diabetic-dyslipidemia and related complications. The ethanolic leaf extracts of Ocimum Sanctum exhibit cognition-enhancing properties, suggesting its potential in promoting cognitive health.

Essential oils derived from Ocimum Tenuiflorum and Ocimum Sanctum exhibit potent antimicrobial properties, inhibiting various pathogens at different concentrations. Furthermore, Tulsi extracts demonstrate effectiveness against microorganisms associated with dental caries and gingivitis. The plant's antimicrobial activity extends to Candida species and Gram-negative bacteria.

In addition to its antimicrobial effects, Tulsi has proven efficacy in managing oxidative stress, offering potential relief from painful neuropathic conditions. The plant extracts, especially NiGs synthesized from Ocimum Sanctum leaf extract, display sensitivity to a range of microbes, indicating their potential as antimicrobial agents.

Ocimum Tenuiflorum exhibits anticancer properties, showing effectiveness against cancer cell lines, including MCF-7, a hormone-dependent breast cancer cell line. The plant extracts demonstrate potential in managing skin infections and wound healing, making them valuable in topical applications.

The therapeutic potential of Tulsi extends to managing stress effects by suppressing cortisol release and inhibiting certain enzyme activities. Extracts from Ocimum Sanctum also show anti-hyperglycemic and anti-hyperlipidemic effects, offering protection against diabetes-related complications.

Tulsi extracts demonstrate notable antipyretic activity, potentially inhibiting the release of inflammatory mediators and prostaglandins. The plant shows promise in managing allergic inflammation, mast cell degranulation, and related allergic responses. Ocimum Tenuiflorum extracts exhibit potential in inhibiting SARS-CoV-2 infection by targeting the spike S1 protein, presenting a potential avenue for COVID-19 treatment.

Table 1
Summary of Theraputic Properties Ocimum Tenuiflorum Linne

No.	Types of study	Dose	Finding	References
1.	Antidiabetic and Antihyperlipidemic	125, 250 and 500 mg/kg	"The hydroalcoholic extract of Ocimum Tenuiflorum exhibited notable anti-diabetic and anti-hyperlipidemic effects at doses of 500 and 250 mg/kg, which were comparable to those of Glibenclamide. Phytochemical screening of the n-hexane extract from Ruku-ruku leaves revealed the presence of secondary metabolites including flavonoids, steroids, alkaloids, saponins, and terpenoids."	Parasuraman et al. (2015)
2.	The antidyslipidemic activity	500 mg/kg b.w.p.o.	"The leaf extract of Ocimum sanctum exhibits antidyslipidemic and antioxidant activities, suggesting its potential use in preventing diabetic-dyslipidemia and related complications."	Husain et al. (2015)
3.	Cognition-Enhancing	300 milligram capsules of EtOS	"The ethanolic leaf extracts of Ocimum sanctum (EtOS) appear to possess potential cognition-enhancing properties in humans."	Sampath et al. (2015)
4.	Antimicrobial Activities	Essential Oils (EOs) 0.125-32 µL/mL	"Tested essential oils inhibited pathogens at 0.125-32 µL/mL, except Pseudomonas aeruginosa, which required higher concentrations. O. sanctum's floral budding oil showed the strongest antibacterial effects against foodborne bacteria."	Saharkhiz et al. (2015)
5.	Anti Microorganisms	Ocimum Sanctum Ethanolic Extract (Concentrations 2.5,5 And 10%)	"At a concentration of 10%, Ocimum sanctum leaf extract exhibited the highest antimicrobial effectiveness against microorganisms associated with dental caries, although 5% and 2.5% concentrations were also effective. The most significant activity was observed against Streptococcus mutans and Streptococcus sanguis with the 10% extract."	Bhat et al. (2015)
6.	Anti-inflammatory activity (periodontitis)	2% tulsi (O. sanctum) gel	"A 2% Tulsi gel reduced edema by 33.66% at 24 hours, impacting Gingival Index and pocket depth significantly. Morphometric analysis found no group differences. No toxicity appeared at 2000 mg/kg oral Tulsi extract."	Hosadurga et al. (2015)
7.	decrease the oxidative stress and calcium levels	100 and 200 mg/kg p.o	"The saponin-rich fraction from Ocimum sanctum shows potential in alleviating painful neuropathic conditions, possibly linked to	Kaur et al. (2015)

			reduced oxidative stress and calcium levels."	
8.	Anti-Cancer	25, 50, 75, and 100 µg/ml)	"Treating NCI-H460 cells with extract (10-150 µg/ml) for 24 hours showed maximum viability reduction at 150 µg/ml. Concentrations of 25-100 µg/ml notably increased ROS, inhibiting cell viability and colony formation, likely due to heightened oxidative stress. The rise in apoptotic cells in Ocimum sanctum highlights its anticancer nature. Extract treatment led to a significant loss of mitochondrial membrane potential, indicating early apoptosis in NCI-H460 cells."	Sridevi et al. (2016)
9.	Anti-microbial Activity	1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10% of extract	"Extract from Ocimum Sanctum (Linn.) exhibited antimicrobial activity against Actinobacillus Actinomycetemcomitans, with the highest potential observed at a 6% concentration."	Eswar (2016)
10.	A potential source of secondary metabolites	Shoot induction was noted at a 1 mg/L concentration of BAP over a period of 30–35 days, resulting in up to 14 shoots per explant, with the longest shoot measuring 2.53 cm.	"In vitro-grown leaves and somatic embryos were found to contain similar levels of eugenol (approximately 85 µg/g), which is higher compared to Ocimum Tenuiflorum L. (OT) leaves grown in the field (25.1 µg/g, and 30.2 µg/g respectively). Additionally, in vitro-grown leaves had a higher total phenolic content (TPC) than the intact organs grown in the field. This highlights the potential of in vitro cultures for eugenol extraction. According to the study, the eugenol pathway may be used to produce significant food flavoring compounds including vanillin and vanillic acids, suggesting that OT may be a useful source of eugenol. Significant phenylpropanoid eugenol (4-allyl-2-methoxyphenol) is present in essential oils of clove, cinnamon, bay leaves, nutmeg, and Ocimum species (Tulsi, Basil)."	Bhuvaneshwari et al. (2016)
11.	antimicrobial activity	5% and 10% concentrations	"Tulsi extracts demonstrated doxycycline-like antimicrobial effects against Aggregatibacter actinomycetemcomitans at doses of 10% and 5%. However, Porphyromonas gingivalis and Prevotella intermedia were resistant to Tulsi, leading to smaller inhibition zones."	Mallikarjun et al. (2016)

12.	Antimicrobial	Fresh leaves and inflorescences (350 grams) were subjected to steam distillation for 6 hours using an essential oil steam distiller.	"The essential oil extracted from Ocimum Tenuiflorum demonstrated antimicrobial activity against S. aureus (including MRSA) and E. coli, though it showed reduced effectiveness against P. aeruginosa. Detailed analysis of the volatile compounds in the essential oil and extracts from leaves and inflorescences identified 54 unique components, with variations in their presence and concentration among the three types of samples. According to literature, camphor, eucalyptol, and eugenol are likely key contributors to the antimicrobial effects of Tulsi oil, while β-caryophyllene, though present in smaller quantities, may also play a role. Given the significance of S. aureus (including MRSA), P. aeruginosa, and E. coli in skin and soft tissue infections (SSTIs), Tulsi essential oil shows potential as an effective topical antimicrobial agent for treating or preventing infections caused by these pathogens."	Yamani et al. (2016)
13.	anti-stress	Ocimum sanctum followed by chronic variable stress (CVS)	"Ocimum sanctum was discovered to effectively manage stress effects, potentially by suppressing cortisol release, blocking CRHR1 receptor, and inhibiting 11β-HSD1 and COMT activities."	Jothie Richard et al. (2016)
14.	Anti-diabetic and anti-oxidative activity	OS leaf powder consumption was 4.45 g/kg/day	"The fixed oil extracted from Ocimum sanctum (OS) leaves exhibited anti-hyperglycemic, anti-hyperlipidemic, and free radical scavenging properties in diabetic rats, providing renal protection against diabetes. The beneficial effects are likely attributed to the presence of α-linolenic acid in the fixed oil."	Suanarunsawat et al. (2016)
15.	Antimicrobial	100 µg/mL NiGs	"NiGs, synthesized from Ocimum sanctum leaf extract, showed higher sensitivity to Gram-negative bacteria and Candida species (25–100 µg/mL) than Gram-positive bacteria and Aspergillus. Antimicrobial activity involved ROS, confirmed by microbial growth with NiGs and ascorbic acid. NiGs induced ROS generation linked to protein and LDH leakage from microbial membranes."	Jeyaraj Pandian et al. (2016)
16.	the insulin secretion and	2.5 mg/kg body weight	"In diabetes, heightened oxidative stress leads to peroxidative	Kumar Jayant & Srivastava,

	anti-oxidative potential		membrane damage, inhibiting antioxidant enzyme activities and insulin secretion by pancreatic beta cells. Oral administration of Ocimum sanctum extracts enhances insulin activity and mitigates oxidative stress complications in diabetic rats."	(2016)
17.	Allergic Inflammation in Human Mast Cells Mediated by Histamine	10 grams of the powder were mixed thoroughly with 100 ml of water	"The aqueous extracts obtained from Ocimum Tenuiflorum Linn (AEOT) demonstrated inhibition of intracellular calcium levels induced by histamine. Additionally, AEOT exhibited a mitigating effect on mast cell degranulation stimulated by compound 48/80, and it also decreased the secretion of IL-13 in HMC-1 cells induced by histamine. Notably, the inhibitory impact of AEOT on the histamine-induced allergic model was determined to be dependent on NF-κB."	Prakash et al., (2017)
18.	Antioverweight and Obese	250 mg capsule of Tulsi	"The positive impacts of Ocinum sanctum (Tulsi) on diverse biochemical parameters in young overweight/obese individuals."	Satapathy et al. (2017)
19.	Antipyretic activity	100mg/kg and 300mg/kg(n=6)	"The extract derived from Ocimum sanctum exhibits notable antipyretic activity, and its mechanism is believed to involve the inhibition of the release of inflammatory mediators and prostaglandins."	Balakrishna et al. (2017)
20.	Anticancer	Methanolic plant extracts (25 and 100 µg/mL)	"Ocimum Tenuiflorum demonstrated anticancer effects against various cancer cell lines, particularly the hormone-dependent MCF-7 breast cancer cell line. The viability of MCF-7 cells significantly decreased as measured by the 3-(4,5-dimethylthiazol-2-yl)2,5-diphenyltetrazolium bromide (MTT) assay. The most effective concentration of Ocimum Tenuiflorum was found to be 25 µg/ml of methanolic extracts after 48 and 72 hours, resulting in 94% and 92.4% viability, respectively. The levels of heavy metals (Pb and As) detected in O. Tenuiflorum are low enough to ensure safety for consumption."	Lam et al., (2017)
21.	Mouthwash with Tulasi (Ocimum sanctum) extract for oral	To Rinse 10 Ml	"Patients diagnosed with oral candidiasis experienced a notable decrease in burning sensation and enhanced taste perception	Annigeri et al. (2018)

	candidiasis		following the treatment. The colony-forming units (CFUs) exhibited a substantial reduction in both groups before and after the intervention. Notably, Tulasi demonstrated statistically significant improvements compared to chlorhexidine.”	
22.	Antifungal	C. neoformans (0.16 μL/mL) and dermatophytes (0.32 μL/mL)	“The essential oils of Ocimum Tenuiflorum L. were analyzed using GC and GC-MS techniques. The predominant compounds identified were methyl eugenol (84.7%) and β-caryophyllene (7.4%). These essential oils were found to inhibit the virulence factors of C. albicans, which are linked to treatment resistance and relapse.”	Piras et al. (2018)
23.	Insecticide	100-1000 μL/L air	“Ocimum Tenuiflorum oil, primarily composed of eugenol and caryophyllene constituting 70.5% of its essential oil composition, was subjected to a space fumigation study to evaluate its fumigant toxicity. Assessments at various concentrations (100-1000 μL/L air) demonstrated that both fumigant and contact toxicity were significantly influenced by concentration and exposure time. In the contact toxicity assay, the essential oil exhibited an LC50 value of 0.376 μL/cm2, with maximum mortality at 0.786 μL/cm2 after 24 hours. In the fumigant toxicity assay, O. Tenuiflorum oil and eugenol displayed LC50 values of 963.3 and 1070.6 μL/L, respectively, after a 6-hour exposure. Furthermore, the essential oil and eugenol impacted acetylcholinesterase activity in-vivo, suggesting their potential as botanical insecticides through the inhibition of acetylcholinesterase activity.”	Bhavya et al. (2018)
24.	Antihyperglycaemic	Oral Extracts (1000 Mg/Kg) For Fourteen Days	“The methanol leaf extract of Ocimum Tenuiflorum, as a medium-polarity solvent extract, potentially exhibits antihyperglycemic effects attributed to its major bioactive compounds, which may have the ability to regulate diabetes.”	Mousavi et al. (2018)
25.	The Treatment of Oral Cancer	100 μg/ml and 400 μg/ml	“In the in vitro cytotoxicity investigation, Tulsi (Ocimum Tenuiflorum) extract demonstrated a direct cytotoxic impact on KB cell lines in a	Hinaz & Geetha (2018)

			concentration-dependent manner, with a determined half-maximal inhibitory concentration value of 100 µg/ml. Notably, at a concentration of 400 µg/ml, the percentage of cell inhibition reached 88.45%, signifying a significant effect when compared to the tamoxifen control, which exhibited 96.35%.”	
26.	Antibacterial on wound	plant extract 2.24% (w/v)	“The gel was tested in vivo using a rat model for skin wound healing. By the 14th day, the silver nanoparticle gel exhibited 96.20% wound healing activity, comparable to the standard and control base. The nano gel's antibacterial efficiency matched a commercial product against Staphylococcus aureus, E. coli, and Pseudomonas aeruginosa.”	Sood & Chopra (2018)
27.	Antioxidant Activities Using DPPH Method	20 kg	“The essential oil from the stems of Ocimum Tenuiflorum L. contained 11 components, with the principal compounds being α-copaene (5.56%), caryophyllene (17.28%), germacrene-D (9.29%), and methyl eugenol (56.72%). Antioxidant activity was assessed using the DPPH method, and the IC50 value, which represents the concentration required to achieve 50% inhibition of free radicals, was determined to be 14.17 µg/mL for the essential oil.”	Hikmawanti et al. (2019)
28.	Anticandidal	2000 µg/ml	“The ethyl acetate extract from mature betel leaf demonstrated superior anticandidal activity compared to extracts from Tulsi and fluconazole.”	Sivareddy et al. (2019)
29.	Antidiabetic and In Vitro Enzyme Inhibition	The extraction (500, 250, 125 mg/kg b.w.)	“All administered doses led to a decrease in blood glucose levels, with the 500 mg/kg dose achieving the most significant reduction, nearly comparable to the effects of metformin. The 14-day study across different doses showed a gradual increase in body weight for all groups, though no significant difference was observed compared to the control group (Metformin 500 mg). In vitro, the α-glucosidase inhibitory activity of the methanol extract of Ocimum Tenuiflorum L. leaves and its fractions demonstrated notable inhibition. The methanol extract showed a concentration-dependent decrease in α-amylase	Mousavi et al. (2020)

			activity inhibition. The methanol crude extract and its active fractions (ethyl acetate/butanol) significantly reduced glucose levels, attributed to their polyphenolic active compounds.”	
30.	Anti-Cancer Activity	The Ocimum Tenuiflorum was dissolved in absolute ethanol to prepare a stock solution with a concentration of 100 mg/mL.	“The essential oil derived from Ocimum Tenuiflorum (OTEO) exhibited a notable, dose-dependent reduction in AGS cell viability, with an IC50 of 163.42 µg/mL, accompanied by effective inhibition of cell migration and invasion. Morphological analysis identified distinctive signs of apoptotic cell death, such as fragmentation, chromatin condensation, and cell shrinkage. Up-regulation of pro-apoptotic genes (TP53, BAX, and BAK) and simultaneous down-regulation of anti-apoptotic genes (BCL-2 and BCL-xL) were observed following OTEO treatment. Furthermore, the expression of CASP3, CASP9, and CASP8 genes significantly increased in AGS cells exposed to OTEO. Gas Chromatography-Mass Spectrometry analysis identified caryophyllene (25.85%) and α-pinene (11.66%) as the major compounds in OTEO.”	Boonyanugomol et al. (2021)
31.	Anti virus	Eugenol (25 mg/kg body weight/d) via gavage for 10 d.	“Holy basil (Tulsi) (Ocimum tenuiflorum) Upon analyzing various components of Holy basil leaf, it was discovered that eugenol, distinct from other major components such as β-caryophylline, oleanolic acid, and ursolic acid, effectively hindered the interaction between ACE2 and spike S1 in an AlphaScreen-based assay. Eugenol demonstrated robust inhibition of pseudotyped SARS-CoV-2 entry into human ACE2-expressing HEK293 cells, contrasting with its impact on vesicular stomatitis virus (VSV). Furthermore, eugenol attenuated SARS-CoV-2 spike S1-induced NF-κB activation, along with a reduction in the expression of TNFα, IL-1β, and IL-6 in human A549 lung cells. In vivo, oral administration of eugenol mitigated lung inflammation, alleviated fever, enhanced heart function, and improved locomotor activities in SARS-CoV-2 spike S1-intoxicated mice. Hence, the	Paidi et al., (2021)

			selective targeting of SARS-CoV-2 spike S1, rather than ACE2, by eugenol presents potential benefits for COVID-19 treatment.”	
32.	Antimicrobial And Anti-Gingivitis	0.2 % chlorhexidine gel with 2 % Ocimum tenuiflorum extract gel	“All three groups (Group C – 2% Ocimum Tenuiflorum gel (n = 20), Group B – Placebo gel (n = 20), Group A – 0.2% Chlorhexidine gel (n = 20)) that met the inclusion criteria participated in this randomized double-blind placebo-controlled trial over 15 days. Each group demonstrated a reduction in both clinical (modified Sulcus Bleeding Index (mSBI), Gingival Index (GI), and Plaque Index (PI)) and microbiological parameters. Both Chlorhexidine gel and Ocimum Tenuiflorum gel demonstrated statistically significant improvements in gingival health compared to the placebo gel at all study intervals. Clinical parameters improved from the 15th day to the 3rd month recall, though they did not return to pre-treatment levels. The research concluded that Ocimum Tenuiflorum gel was as effective as chlorhexidine gel in reducing plaque and gingivitis within the study period.”	Jankish et al. (2021)
33.	Antioxidant	20 mg/kg/day for 1 week	“The administration of filgrastim has been observed to induce degeneration in spermatozoa and germ cells within the testicles of rats. However, Ocimum Tenuiflorum exhibits ameliorative effects on the testicles and fertility of rats subjected to filgrastim treatment. The protective influence of Ocimum Tenuiflorum extends to testis tissues, thereby safeguarding reproductive functions in male rats.”	Tuimah Alabedi et al. (2021)
34.	Anesthesia	75 mg L-1, 50 mgL-1, 25 mg L-1, and 0 mg L-1, and 3 replications	“The varying doses of holy basil leaf oil did not significantly impact the survival rate of catfish during transportation and acclimatization, remaining at 100% and 98-100%, respectively.”	Maryani et al. (2022)
35.	The Potential Anti-Inflammatory Mechanisms	0.5 kg use the MS/ HPLC/ESI-MS analysis, up to 22 of the identified peaks were provisionally	“Using the identified molecules, a consensus target prediction was conducted. Among the primary predicted target proteins, a significant presence of the carbonic anhydrase family (CA7,	Beltrán-Noboa et al. (2022)

		recognized.	CA12, and CA2) and key proteins involved in the arachidonic acid pathway (COX2, COX1, LOX5, and PLA2) was detected. Both pathways are strongly associated with inflammation. The interaction of these compounds with the identified targets was extensively analyzed using molecular dynamics and molecular docking simulations. This analysis indicated that certain molecules might elicit an anti-inflammatory response through a non-steroidal mechanism related to carbon dioxide metabolism.”	
36.	Antibacterial and Anti-inflammatory Activities	500 g of sample was dried at 60 °C and then powdered into fine powder	“Mastitis, a prevalent bacterial infection in dairy cows, is an infection of the breast tissue characterized by changes in the mammary glands and inflammation. The anti-mastitis properties of Ocimum Tenuiflorum ethanolic extract include: (i) antibacterial activity against Gram-positive bacteria such as S. Agalactiae, S. Aureus, and CNS, but not against Gram-negative bacteria, (ii) synergistic effects when combined with penicillin against all tested strains, while showing additive effects with amikacin, and cefazolin, and (iii) anti-inflammatory activity, demonstrated by reduced expression of inflammatory markers in LPS-treated macrophages. Further research is needed to determine the optimal route and dosage for therapy in animal models.”	Srichok et al. (2022)
37.	Anticancer agents	0, 25, 50, 100, 250 and 500 µg/ml	“250 mg of the extracts were dissolved in 1.0 ml of ethanol and then filtered through a 0.22 µM filter. The leaf extract demonstrated anti-cancer and cytotoxic activities against breast cancer cells, with relatively low toxicity. The cytotoxic effect of this fraction inhibited cell growth and seemed to induce apoptosis in the cells.”	Marvell & Ervina (2022)
38.	Antibacterial	Leaf extracts concentrations of 80,000, 100,000, 120,000 and 140,000 ppm	“Showed no inhibitory zones against Shigella dysenteriae bacteria. The antibacterial efficacy of Ruku-ruku leaf extract is still insufficient to substitute ciprofloxacin antibiotics.”	Rahmat Ramadhan et al. (2023)
39.	Antistress activity	Ocimum tenuiflorum extract (12.5, 25,	“Ocimum tenuiflorum extract at doses of 12.5 and 25 mg/kg body weight demonstrated the greatest	C. M. et al. (2023)

		and 50 mg/kg)	improvement in endurance in mice compared to the 50 mg/kg dose. The standardized extract of Ocimum Tenuiflorum provides antistress benefits even at very low doses, as shown in two in vivo studies. Its antistress effects may be attributed to the inhibition of cortisol release and the antagonistic action on CRF1 receptors, which helps regulate the HPA axis. Recent clinical studies have confirmed the antistress effects of HolixerTM (a clinically evaluated standardized Ocimum tenuiflorum extract) at lower doses in individuals experiencing stress.”	
40.	Antibactericidal	100 g were boiled with distilled water (110 mL) at 40–50 °C	“This study focused on the green synthesis of ZnMoO4 and Mn-ZnMoO4 nanomaterials from Tulsi, characterized using various techniques. Both nanomaterials exhibited antibacterial and photocatalytic properties. Mn-ZnMoO4 showed higher efficacy against Escherichia coli and Staphylococcus aureus than ZnMoO4. Photocatalytic abilities were demonstrated by reactive oxidative species generation, leading to the photodegradation of solochrome dark blue dye (SDB). Mn-doped ZnMoO4 achieved faster decolorization (80 minutes) compared to ZnMoO4 (120 minutes) under light and air exposure.”	Singh et al. (2023)

3.2. Discussion

Based on the results in Table 1, the author can narrate into 7 points: 1) culinary use vs. medicinal potential; 2) cultural significance and medicinal heritage; 3) therapeutic properties of Holy Basil (Ocimum tenuiflorum); 4) historical use and modern relevance; 5) diverse formulations and applications; 6) phytochemical screening as a gateway; 7) potential for COVID-19 treatment.

First point, culinary use vs. medicinal potential. The dichotomy between the culinary use of Ruku-ruku and its untapped medicinal potential underscores the necessity for comprehensive studies (Parbuntari et al., 2019; Sulianti, 2008). Bridging the gap between traditional culinary practices and scientific exploration is crucial to fully understand and utilize Ruku-ruku's medicinal properties.

Second point, cultural significance and medicinal heritage. Holy Basil's immense cultural significance, particularly in Hinduism, aligns with its deep-rooted medicinal heritage (Akbar, 2020). References in ancient Indian medical texts emphasize the intrinsic connection between cultural traditions and the utilization of herbal medicine (Shasany, 2016).

Third point, therapeutic properties of Holy Basil (Ocimum tenuiflorum). The diverse therapeutic properties attributed to Holy Basil, including antidiabetic, anti-inflammatory, anti-cancer, and antioxidant activities, demonstrate its potential across various health domains (Bhavya et al., 2018). The plant's versatility in promoting cardiovascular, cognitive, and oral health, as well as its application in wound healing and weight management, highlights its holistic benefits.

Fourth point, historical use and modern relevance. The enduring historical use of Tulsi, dating back to ancient texts like the Rigveda, underscores its adaptability and relevance in addressing contemporary health challenges (Bano et al., 2017). Its role as an adaptogen positions it as a timeless remedy against evolving health issues.

Fifth point, diverse formulations and applications. The diverse formulations of Ocimum tenuiflorum Linne, including essential oils, gels, and capsules, reflect its adaptability to different medicinal contexts (Parasuraman et al., 2015). The various concentrations and dosage forms used in studies contribute to understanding its optimal therapeutic applications, supporting its integration into pharmaceutical practices.

Sixth point, phytochemical screening as a gateway. Phytochemical screening emerges as a crucial gateway to unlocking the full potential of medicinal plants (Davis & Choisy, 2024; Kebede et al., 2021). The preliminary test for Ruku-ruku emphasizes the importance of identifying secondary metabolites, while Holy Basil's rich chemical composition, including alkaloids, flavonoids, steroids, terpenoids, and saponins, contributes to its therapeutic efficacy (Parbuntari et al., 2019; Sulianti, 2008).

Seventh point, potential for COVID-19 Treatment. The intriguing potential of Ocimum tenuiflorum Linne in inhibiting SARS-CoV-2 infection by targeting the spike S1 protein provides a novel avenue for natural remedies in the context of viral infections, including efforts against COVID-19 (Nath & Debnath, 2023; Parasuraman et al., 2015).

4. CONCLUSION

The rich botanical diversity of Indonesia presents a promising landscape for the emergence of the country as a major producer of medicinal plants. However, the prevailing trend of utilizing plants based on personal experiences without a thorough understanding of their medicinal content underscores the need for systematic exploration. The case of Ruku-ruku (Ocimum tenuiflorum Linne), primarily recognized for its culinary applications, exemplifies the untapped potential within traditional plants. The cultural and medicinal significance of Ocimum sanctum, commonly known as Holy Basil or Tulsi, further emphasizes the profound impact of traditional knowledge on herbal medicine. With roots in ancient Indian medical texts and recognized as a life-saving herb, Tulsi's distribution across diverse regions highlights its adaptability and widespread recognition. The therapeutic properties attributed to Holy Basil, ranging from anti-diabetic and anti-inflammatory to antimicrobial and anticancer effects, showcase its versatility in addressing various health conditions.

The phytochemical screening of Ruku-ruku and Holy Basil becomes crucial in identifying the bioactive compounds within, with a particular focus on essential oils. This preliminary qualitative test serves as a gateway to unlocking the full potential of these plants as medicinal resources, paving the way for further investigations and maximizing their therapeutic functions.

In summary, the integration of traditional knowledge with modern research methodologies is imperative for harnessing the full therapeutic potential of Ocimum tenuiflorum Linne and similar medicinal plants. The continuous exploration of their diverse applications, formulations, and mechanisms of action not only preserves cultural heritage but also contributes to a holistic approach to healthcare, potentially offering new avenues for treatments, including in the context of emerging health challenges like COVID-19.

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