Chemical compositions and biological activities of *Commiphora gileadensis*: A review

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Abstract.

Background: A significant medicinal plant with several medicinal applications is *Commiphora gileadensis*. Due to the *C. gileadensis* medicinal properties, such as anti-cancer, antibacterial, antioxidant, cytotoxic, and antiviral activities, secondary phytoconstituents of the plant are crucial for medicine. ***Objective***: This review aims to identify the biological activities and chemical compositions of C. *gileadensis*. ***Method***: Data for the study were gathered from book chapters, research articles, review articles, and conference papers as part of the study's review approach, which was based on a thorough search of the literature. ***Results***: Based on the results obtained, it may be inferred that the chemical composition and lipid constituents of C. gileadensis extracts provide substantiation for their utilisation in traditional medicinal practises. The primary chemical constituents seen in the sample were β-pinene (7.0% ± 0.1%), cymene (13.6 ± 0.1%), α-pinene (14.4%), terpinen-4-ol (18.7 ± 0.1%), and sabinene (22.7 ± 0.1%). Additionally, the sample exhibited the presence of various lipids, including phosphatidylethanolamine (PE) at a concentration of 7.6%, hexosylceramide (Hex1Cer) at 18%, and ceramide (Cer) at 69%. ***Conclusion***: As a result, this review presented an overview of *C. gileadensis'* biological activities and chemical compositions. The review suggests that more attention be paid to the leaves barks. It stems from *C. gileadensis*, as well as the type of extraction techniques and advanced characterization because extending research materials could lead to the discovery of novel bioactive components.

Keywords: Chemical compositions, *Commiphora gileadensis*, biological properties, Phytochemicals.

1. Introduction

The genus *Commiphora* encompasses a total of 190 plant species, distributed in the Indian subcontinent (India, Pakistan), northeastern Africa (Somalia, Ethiopia, and Sudan), and southern Arabia (Yemen and Oman) (Alhazmi et al., 2022; Khan et al., 2019a; Mokaizh et al., 2022). The plant species called *C. gileadensis* (**Figure 1**) is a shrub that typically reaches heights ranging from 1 to 3 metres. It belongs to the Burseraceae family and the genus *Commiphora* (Alsherif, 2019; Bouville et al., 2019; Shadid et al., 2023). *C. gileadensis* has been identified in the southern region of the Arabian Peninsula within the Kingdom of Sheba, as reported by Doa et al. (2016) and Eslamieh (2011). The substance in question was often known as (Old World) balsam, Mecca balsam, and Judaea balsam, as documented by Schottenhammer in 2020. *C. gileadensis*, also called *Commiphora Opobalsamum*, is commonly recognised as the Balm of Mecca in the Mediterranean Basin, particularly in the vicinity of Yemen, Saudi Arabia, Oman, and Eritrea. This nomenclature is supported by various scholarly sources (Al-Hazmi et al., 2020; Al-sieni, 2014; Bouslama et al., 2019; Khan et al., 2019a). The plant is known as balsam (Khan et al., 2019b; Yehoshua et al., 2015). The plant *C. gileadensis*, commonly referred to as besham or becham in regional contexts, exhibits a wide distribution in Yemen and Saudi Arabia and is prominently employed in the Middle East for its medicinal properties (Alsherif, 2019; Serjeant, 1989). Besham, a large aromatic shrub, possesses a vertical stature ranging from 10 to 12 feet (Bouslama et al., 2019; Doa rsquo an et al., 2016). The Gilead balm, also referred to as apharsemon and scientifically classified as *C. gileadensis* (Yehoshua et al., 2015), is recognised as one of the most renowned therapeutic herbs from ancient times. During ancient times, apharsemon, sometimes called balsam of Judea, was predominantly limited to the Dead Sea Basin. This crop garnered significant recognition due to its exceptional aroma and valuable medical attributes. Nevertheless, the species in question has been deemed extinct for a considerable duration, as supported by the research conducted by Alhazmi et al. (2022) and Ben-Yehoshua et al. (2012). The several designations, namely "balm of Gilead," "Judea Balm," "balsam of Mecca," and "balm of Judean," collectively denote a singular valuable substance, which was historically employed in the realms of fragrance and therapeutics (Bouville et al., 2019). The aromatic extract is derived from a shrub known scientifically as *C. pobalsamum* (L.) Engl. and C. gileadensis (L.) C. Chr. (Ben-Yehoshua et al., 2012; Bouville et al., 2019).

C. gileadensis has been historically utilised for therapeutic purposes since ancient times, as documented in biblical texts. This plant species continues to be employed in traditional medicinal practises within several Middle Eastern countries (Al-sieni, 2014; Eslamieh, 2011; Iluz et al., 2010). Furthermore, it has been observed that C. gileadensis exhibits a robust inhibitory impact on cancer cell lines, in addition to its therapeutic applications in managing various ailments such as pain and inflammation (Alsherif, 2019). Furthermore, it has been shown that this intervention has therapeutic advantages in managing several symptoms, such as urine retention, headache, jaundice, constipation, liver dysfunction, gastrointestinal disturbances, inflammatory conditions, and joint discomfort (Yehoshua et al., 2015). The utilisation of balsam derived from *C. gileadensis* as a fragrant substance during the Roman and Hellenistic periods has been documented in several scholarly works (Al-Mahbashi et al., 2019; Singh et al., 2018; Tekwu et al., 2012).

In contrast, a comprehensive examination of the aerial components of this plant unveiled the existence of flavonoids, triterpenes, sterols, saponins, volatile bases, and oils, as reported by Almulaiky and Al-Farga (2020). The resin of *C. gileadensis*, an agricultural item, holds the record for the highest price ever paid, amounting to twice the weight of gold. Yehoshua et al. (2015) also examined the anti-cancer properties of the ancient plant against various cancer cell lines. The resin derived from *C. gileadensis* is frequently employed in manufacturing perfumes, aromatherapy items, and pharmaceutical preparations (Khan et al., 2019a). Resin-based treatments have been used in traditional medicine to address a range of health conditions, including obesity, parasite infections, wounds, gastrointestinal disorders, arthritis, and wound-related discomfort (Almulaiky & Al-Farga, 2020; Bouslama et al., 2019; Khan et al., 2019a).

Similarly, conventional medicine employs many plant parts such as wood, bark, seeds, sap, and leaves (Shen et al., 2012). In the past, *C. gileadensis* was utilised as a botanical ingredient to produce incense and scent (Mahr, 2012). When the bark is damaged, it produces a resin that possesses an oily fragrance. The plant is widely recognised for its advantageous attributes in promoting health and its highly valued aromatic resin (Abdallah et al., 2022). Moreover, the utilisation of antimicrobial *C. gileadensis* has been observed in the treatment of illnesses, as documented by Iluz et al. (2010). The utilisation of traditional Arabic medicine in certain African countries has been established to treat opportunistic fungal infections, as well as for cancer pain relief and diuretic effects (Iluz et al., 2010; Mahr, 2012). Chewing sticks derived from the *C. gileadensis* genus are commonly employed for oral hygiene practises in the Arab Gulf region.

Additionally, adherents of the Islamic faith consistently utilise this plant for ongoing dental care (Abdallah et al., 2022). The World Health Organisation recommends the utilisation of chewing sticks as an effective method for maintaining oral hygiene in areas where their usage is prevalent (Abdallah et al., 2022).

The primary objective of this review study is to provide a comprehensive overview and critical analysis of the existing research on the chemical compositions and biological activities associated with C. gileadensis.

Figure 1: *Commiphora gileadensis* Genus (Eslamieh, 2011).

2. Review Approaches

The research method is based on an in-depth analysis of the literature. Data from research articles, peer-reviewed articles, conference papers, and book chapters were used in this investigation. The data were analyzed, and the research's conclusions were distilled using a theme approach methodology.

3. *C. gileadensis* Chemical Composition

The *C. gileadensis* genus is recognised for its abundance of natural bioactive chemicals, which have been utilised for promoting well-being and addressing various diseases (Almulaiky & Al-Farga, 2020; Sharma et al., 2009). The utilisation of herbal medicine has had a notable surge in popularity recently as a viable approach for addressing various medical conditions (Almulaiky & Al-Farga, 2020; Ashraf et al., 2011). The chemical composition of the essential oil (EO) derived from *C. gileadensis* was investigated through the utilisation of Static Headspace Solid Phase Micro Extraction (HS-SPME), direct injection (DI), and Gas chromatography-mass spectrometry and Gas chromatography with flame-ionization detection (GC-MS & GC/FID) techniques. A comparative analysis was also conducted to evaluate the results obtained from these analytical methods. Like the resin, the volatile component is characterised by a significant abundance of oxygenated and hydrocarbon monoterpenes. The primary constituents of the essential oil (EO) were found to be β-pinene (7.0% ± 0.1%), cymene (13.6% ± 0.1%), α-pinene (14.4%), terpinen-4-ol (18.7% ± 0.1%), and sabinene (22.7% ± 0.1%). Terpinen-4-ol, in substantial quantities, was previously detected in the volatile fraction of Judean balm. The essential oil's olfactive profile can be partially explained by the abundance of terpinen-4-ol, which emits an earthy fragrance with woody and spicy undertones, and cymene, which emits a terpenic odour with spicy and woody characteristics (Bouville et al., 2019). The essential oil's scent resembles the balm's, which share nearly identical components. In contrast to a polar column separation, using polar column separation enabled the identification of an additional 28 compounds. The observed result may be ascribed to various factors, including the specific geographic region where the shrubs were grown, the specific conditions under which they were cultivated, the method employed for extraction, or the specific portion of the harvested plant. The chemical components of *C. gileadensis* were identified using various approaches, and the results are presented in **Table 1**.

More so, numerous experiments have examined the chemical constituents of the extract derived from the C. gileadensis plant. The analysis of *C. gileadensis* stem peels and leaves using gas chromatography-mass spectrometry (GC-MS) is presented in **Tables 2** and **3**, respectively. The stem peel extract in 80% methanol revealed the presence of twenty elements, while the leaf extract in the same solvent included nineteen elements (Al-Hazmi et al., 2020).

Table 1: Summary of *C. gileadensis* chemical compounds' classifications using DI, HS-SPME, and GC-MS & GC/FID.

Compounds classification	GC-MS & GC/FID	DI	HS-SPME
	Number (%)	Number (%)	Number (%)
Hydrocarbons	11 (tr)	1(tr)	2(0.1)
Oxygenated monoterpenes	49 (25.8)	29 (4.0)	31 (1.9)
Monoterpene hydrocarbons	24 (70.8)	20 (85.8)	22 (96.3)
Oxygenated sesquiterpenes	9 (tr)	1(tr)	-
Sesquiterpene hydrocarbons	16 (0.6)	6 (0.1)	6 (tr)
Diterpene hydrocarbons	1 (tr)	1(tr)	1 (tr)
Unknown compound	2 (1.1)	12 (8.8)	-
Others	22 (0.3)	6 (tr)	10 (0.1)
Total of identified	132 (97.9)	64 (89.9)	72 (98.7)

Table 2: The phytochemical contents of *C. gileadensis* stem peels extracted were analysed using GC-MS.

	Compound Name	Mol. weight	Mol. formula
1	α-Pinene	136.238	$C_{10}H_{16}$
2	2-Ethylhexyl 2-ethylhexanoate	256.42	$C_{16}H_{32}O_2$
3	Benzoic acid, 2-ethylhexyl ester	234.33	$C_{15}H_{22}O_2$
4	Octanoic acid, 2-ethylhexyl ester	256.42	$C_{16}H_{32}O_2$
5	Naphthalene, 1,2,3-trimethyl 4-propenyl, (E)	210.31	$C_{16}H_{18}$
6	1-Octadecanesulphonyl chloride	353	$C_{18}H_{37}ClO_2S$
7	1,1'-Biphenyl, 2,2',5,5'-tetramethyl-	210.13	$C_{16}H_{18}$
8	tert-Hexadecanethiol	258	$C_{16}H_{34}S$
9	2-Octyl benzoate	234.33	$C_{15}H_{22}O_2$
10	p-Toluic acid, 2ethylhexyl ester	248.36	$C_{16}H_{24}O_2$
11	Pentadecane	212.42	$C_{15}H_{32}$
12	p-Toluic acid, 2-ethylhexyl ester	248.36	$C_{16}H_{24}O_2$
13	2,2-Dichloro1,1bis(4-methoxyphenyl) ethane	311.2	$C_{16}H_{16}Cl_2O_2$
14	Cholestan-3-ol, 2-methylene, (3á,5á)	400.7	$C_{28}H_{48}O$
15	Nonanoic acid, dodecyl ester	326.6	$C_{21}H_{42}O_2$

Table 2: Continued.

	Compound Name	Mol. weight	Mol. formula
16	1-Heptatriacotanol	537	$C_{37}H_{76}O$
17	Benzene, (1-methyldodecyl)-	260.45	$C_{19}H_{32}$
18	Dibutyl phthalate	278.34	$C_{16}H_{22}O_4$
19	Bicyclo [9.3.1] pentadeca3,7dien-12-ol,4,8,12,15,15-pentamethyl, [1R(1R*,3E,7E,11R*,12R*)]	290.5	$C_{20}H_{34}O$
20	Stigmasta-3,5-dien-7-one	410.7	$C_{29}H_{46}O$

Table 3: The phytochemical contents of the leaves extracted from *C. gileadensis* were analysed via GC-MS.

	Compound Name	Mol. weight	Mol. formula
1	p-Cymene	134.22	$C_{10}H_{14}$
2	2,7-Diphenyl 1,6-dioxopyridazino [4,5 : 2',3'] pyrrolo [4',5'd] pyridazine	355.3	$C_{20}H_{13}N_5O_2$
3	Dasycarpidan-1-methanol, acetate (ester)	326.4	$C_{20}H_{26}N_2O_2$
4	9,12,15-Octadecatrienoic acid, 2-[(trimethylsilyl)oxy]-1 [[(trimethylsilyl)oxy] methyl] ethyl ester	496	$C_{27}H_{52}O_4Si_2$
5	p-Toluic acid, 2ethylhexyl ester	248.36	$C_{16}H_{24}O_2$
6	2-Myristynoyl pantetheine	484.7	$C_{25}H_{44}N_2O_5S$
7	Pentadecane	212.41	$C_{15}H_{32}$
8	l-Gala-l-ido octose	240.21	$C_8H_{16}O_8$
9	Carotene,1,1',2,2'-tetrahydro-1,1'-dimethoxy-	601	$C_{42}H_{64}O_2$
10	Hexanoic acid, 3,5,5-trimethyl-,1,2,3-propanetriyl ester	512.8	$C_{30}H_{56}O_6$
11	L-α-Terpineol	154.2	$C_{10}H_{18}O$
12	Bicyclo [9.3.1] pentadeca-3,7-dien-12-ol, 4,8,12,15,15-pentamethyl	290.5	$C_{20}H_{34}O$
13	Geranyl isovalerate	238.37	$C_{15}H_{26}O_2$
14	Hexadecane	226.44	$C_{16}H_{34}$
15	Heptadecane	240.75	$C_{17}H_{36}$
16	Benzene, (1-pentylheptyl)-	246.4	$C_{18}H_{30}$
17	Dibutyl phthalate	278.34	$C_{16}H_{22}O_2$
18	Phytol	296.5	$C_{20}H_{40}O$
19	Octanoic acid, dodecyl ester	312.5	$C_{20}H_{40}O_2$

In a recent investigation by Alhazmi et al. (2022), applying Liquid chromatography-mass spectrometry (LC–MS) was employed to characterise methanolic extracts of *C. gileadensis*. The

LC-MS chromatographic profile in the negative mode revealed the identification of several lipid constituents, as depicted in Table 4. Phosphatidic acid (PA) was detected at a concentration of 0.97%, while dimethylphosphatidylethanolamine (dMePE) was found at a concentration of 2%, both of which were observed to be present in relatively low quantities. Conversely, phosphatidylethanolamine (PE) was abundant, constituting 7.6% of the sample. Additionally, hexosylceramide (Hex1Cer) was observed to be present in high abundance, accounting for 18% of the sample, while ceramide (Cer) was found to be the most abundant lipid, comprising 69% of the sample. Cer, Hex1Cer, and PE all possess elevated concentrations of monounsaturated lipid acids, with only Hex1Cer demonstrating minimal quantities of polyunsaturated fatty acids.

Table 4: LC-MS identified lipid classes in *C. gileadensis* methanolic extracts.

	Class	%
1	Phosphatidylinositol-P2 (PIP-2)	**0.00**
2	Monogalactosyldiacylglycerol (MGDG)	**0.01**
3	Lysosphingomyelin (LSM)	**0.01**
4	Phosphatidylinositol-P (PIP)	**0.01**
5	Lysophosphatidylglycerol (LPG)	**0.01**
6	Phosphatidylserine (PS)	**0.01**
7	Lysophosphatidylethanol (LPEt)	**0.01**
8	Phosphatidylcholine (PC)	**0.01**
9	Fatty acid (FA)	**0.01**
10	Digalactosylmonoacylglycerol (DGMG)	**0.01**
11	Monolysocardiolipin (MLCL)	**0.01**
12	Sphingosine phosphate (SPHP)	**0.01**
13	Phosphatidylethanol (PEt)	**0.02**
14	(O-acyl)-1-hydroxy fatty acid (OAHFA)	**0.03**
15	Lysophosphatidylcholine (LPC)	**0.03**
16	Dilysocardiolipin (DLCL)	**0.03**
17	Lysophosphatidylinositol (LPI)	**0.04**
18	Phosphatidylmethanol (PMe)	**0.04**

Table 4: Continued.

	Class	%
19	Phosphatidylglycerol (PG)	**0.08**
20	Lysophosphatidic acid (LPA)	**0.10**
2	Ceramide phosphate (CerP)	**0.15**
22	Lysodimethylphosphatidylethanolamine (LdMePE)	**0.30**
23	Cyclic phosphatidic acid (cPA)	**0.30**
24	Phosphatidylinositol (PI)	**0.63**
25	Phosphatidic acid (PA)	**0.97**
26	Dimethylphosphatidylethanolamine (dMePE)	**2.19**
27	Phosphatidylethanolamine (PE)	**7.64**
28	Hexosylceramide (Hex1Cer)	**18.19**
29	Ceramide (Cer)	**69.15**
Total		100.00

4. *C. gileadensis* Biological Activities

The therapeutic properties of balsam derived from *C. gileadensis* have been well recognised for their efficacy and significance in medical treatment, namely in wound healing and managing various ailments (Ben-Yehoshua et al., 2012). Extensive research has been conducted to investigate the biological properties of C. gileadensis exudate and essential oil. However, limited attention has been given to exploring the plant's potential in wound healing. The resin and essential oil's antibacterial properties and anti-proliferative activity have been demonstrated in cancer cell lines (Iluz et al., 2010; Yehoshua et al., 2015). In order to assess the conventional applications, anti-aging, and anti-inflammatory properties of the resin, as well as the broader enzymatic activity of the essential oil, a series of in vitro bioassays were conducted. Enzymatic bioassays offer the advantages of simplicity, efficiency, and convenience despite multiple approaches (in vitro, in silico, ex vivo, and in vivo) for evaluating the biological activity of natural extracts (Yaniv & Dudai, 2014). The samples underwent testing to assess their potential anti-collagenase properties relevant to wound healing and anti-aging effects. Additionally, the samples were evaluated for their anti-elastase, antioxidant, anti-hyaluronidase, anti-tyrosinase (whitening activity), and anti-lipoxygenase (anti-aging, wound-healing, and anti-inflammatory properties).

The essential oil and resin had significant inhibitory effects on lipoxygenase activity, with the essential oil demonstrating even greater potency compared to the control sample. The iron-containing enzyme, commonly called lipoxygenase, has been found to have a substantial role in the inflammatory process. This process is achieved through the catalysis of hydroperoxides derived from polyunsaturated fatty acids, synthesizing pro-inflammatory chemicals (Yaniv & Dudai, 2014). The therapeutic application of the shrub in treating wounds, inflammation, and injuries may be ascribed to the anti-inflammatory characteristics exhibited by the resin and essential oil (Bouville et al., 2019). The findings from the resin samples are consistent with previous studies that have reported the presence of anti-inflammatory properties in several extracts (such as ethanol, petroleum ether, methanol, and ethyl acetate) derived from the aerial parts of the plant (Bouville et al., 2019).

Furthermore, it is worth noting that *C. gileadensis* continues to be traditionally employed in Eastern countries to alleviate pain and reduce inflammation (Bouville et al., 2019). Both samples exhibited moderate antioxidant and whitening properties and significantly diminished inhibitory activity. The antioxidant capabilities of resins and essential oils were evaluated by measuring their ability to scavenge the stable radical 1.1-diphenyl-2-picrylhydrazyl (DPPH). Hence, the main objective of the bioassay was to assess the ability of resin and essential oil samples to mitigate the skin's susceptibility to accessible radical-induced damage. Previous studies have demonstrated that the extract derived from *C. gileadensis* possesses antioxidant capabilities (Bouville et al., 2019).

Moreover, despite the limited capacity for inhibition, resin demonstrates anti-collagenase and anti-elastase characteristics. The enzymatic activities of hyaluronidase, elastase, and collagenase impact the skin's firmness, wetness, elasticity, and suppleness. Hyaluronidases, a specific group of enzymes, are responsible for the degradation of hyaluronic acid, a glycosaminoglycan with a high molecular weight, constituting a component of the extracellular matrix. According to Termentzi et al. (2012), The remarkable capacity of the macromolecule to bind and retain water molecules results in its occupation of intercellular gaps and its contribution to tissue hydration and cohesion. Hyaluronic acid plays a significant role in skin regeneration and the body's innate healing mechanisms due to its widespread distribution throughout the body, particularly in proximity to elastin fibres and collagen (Papakonstantinou et al., 2012). The investigation found no evidence of anti-hyaluronidase action in the resin and essential oil of *C. gileadensis*.

Collagen and elastin, two essential proteins, collaborate in conferring structural integrity to the skin. The degradation of skin stiffness is facilitated by elastase, a serine protease, as documented by Ramata-Stunda et al. (2013). Finally, collagen is a fibrous glycoprotein found in the extracellular matrix that plays a crucial role in maintaining the tensile strength of the skin. Collagenases, a class of enzymes, are responsible for the degradation of collagen molecules by cleaving their helical region. The significance of the balm's ability to block collagenase and elastase enzymes, which are crucial for wound healing and skin elasticity, is of utmost importance in validating its potential historical use in medicine despite its relatively moderate inhibitory capacity. The results presented in this study are consistent with the historical utilisation of Judea balm, particularly throughout the Middle Ages, to extend youthfulness, preserve the body postmortem, and postpone mortality (Roy et al., 2013). The wound-healing process also encompasses the participation of elastase and collagenase enzymes. Cicatrisation is a term used to describe the inherent physiological mechanisms that result in the restoration of skin integrity after injury to the skin (Bouville et al., 2019). The process consists of three primary steps: a remodeling stage associated with wound closure, a proliferative stage involving tissue development, and an inflammatory stage related to restoring homeostasis. Cicatrization is a complex operation encompassing a range of activities within one of three distinct stages. The wound-healing response can be influenced by alterations in the equilibrium between protein synthesis and breakdown, particularly with enzymes. The skin regeneration process is characterised by an elevation in proteases, including collagenase, elastase, and hyaluronidase, as well as a pronounced inflammatory response (Bouville et al., 2019). Given that elastin and collagen play a crucial role in the process of wound healing, the ability of our resin to inhibit the enzymes responsible for their degradation, as well as its anti-inflammatory properties (specifically targeting lipoxygenase), may provide a plausible explanation for the historical and cultural utilisation of *C. gileadensis*, specifically to its therapeutic effects on wound healing (Bouville et al., 2019).

5. Conclusion

The present study included an analysis of the chemical and lipid constituents of *C. gileadensis*. The primary chemical constituents seen in the sample were β-pinene (7.0% ± 0.1%), cymene

(13.6 ± 0.1%), α-pinene (14.4%), terpinen-4-ol (18.7 ± 0.1%), and sabinene (22.7 ± 0.1%). Additionally, the sample exhibited the presence of various lipids, including phosphatidylethanolamine (PE) at a concentration of 7.6%, hexosylceramide (Hex1Cer) at 18%, and Ceramide (Cer) at 69%. The research findings have established that the therapeutic properties of *C. gileadensis* extracts are attributed to diterpenoids and triterpenoids, which play a crucial role in exhibiting anti-inflammatory effects. Additionally, these extracts contain ligands that contribute to their toxicity and cytotoxic activity and sesquiterpenoids responsible for analgesic, muscle-relaxing, and antimicrobial properties. Various steroids exhibit phytochemical properties contributing to their potential therapeutic effects in treating diabetes, lipid disorders, inflammation, and abnormal cell growth. *C. gileadensis* is a botanical species with potential ethnomedicinal properties that could be beneficial in addressing tropical diseases. Hence, it is plausible that these compounds possess the potential to be formulated as medicines with anti-inflammatory and anti-cancer properties. The results of this study provide evidence that aligns with the ethnopharmacological applications of the *C. gileadensis* genus in several geographical areas. Additionally, these findings lend credence to the traditional utilisation of *C. gileadensis* as an agent for reducing inflammation. Further investigation is required to ascertain and substantiate the efficacy of *C. gileadensis* leaves, barks, and stems, along with the appropriate extraction methodologies and sophisticated characterization methods.

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Conflicts of Interest:

The authors declare no conflict of interest.

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