Abstract: In this critical review, plant sources used as effective antibacterial agents against *Helicobacter pylori* infections are carefully described. The main intrinsic bioactive molecules, responsible for the observed effects are also underlined and their corresponding modes of action specifically highlighted. In addition to traditional uses as herbal remedies, in vitro and in vivo studies focusing on plant extracts and isolated bioactive compounds with anti-*H. pylori* activity are also critically discussed. Lastly, special attention was also given to plant extracts with urease inhibitory effects, with emphasis on involved modes of action.

Keywords: plant products; *Helicobacter pylori*; opportunistic colonization; phytopharmacology; in vitro/in vivo findings; anti-urease activity
1. Introduction

Plant products, their enriched-derived extracts, and their isolated bioactive molecules have been increasingly studied due to their renowned health attributes, largely used in folk medicine over centuries for multiple purposes [1–9]. Indeed, phytomedicine is garnering much attention among the medical and scientific communities [10–12]. Commercially available synthetic drugs have often been negatively pointed out due to their side effects and related toxicity [13]. In fact, the active molecules used in pharmaceutical formulation are formerly derived from bioactive molecules extracted from plants and other living organisms [14]. Also, a growing number of studies have progressively underlined the multiple bioactive properties conferred by plant formulations [15,16]. Specifically, the antimicrobial effects of multiple plant preparations have been progressively confirmed and supported by both in vitro and in vivo studies and clinical trials [17–21]. Thus, their lower costs, high effectiveness, bioavailability, bioefficacy, and few to no adverse effects have led to intensive research on this topic [22–28].

Among the various opportunistic infections, those caused by Helicobacter pylori, a human opportunistic pathogen, is attracting much attention [29]. In fact, it is widely recognized that this bacterium plays an important role in the etiology of peptic and gastric ulcers and even gastric cancers and gastric lymphomas [29]. About half of the worldwide population is colonized by this bacterium, but there are only about 20% who manifest clinical symptoms, which has been linked to the ability of some H. pylori strains to both adapt to host’s immunological responses and to support an ever-changing gastric environment [29]. Relatedly, increasing rates of antibiotic-resistant H. pylori strains have been found, and therefore, the search for new eradication strategies and effective antibiotic therapies has become an issue of crucial importance [30]. Hence, research effort is focused on exploring plants as sources of anti-H. pylori agents.

Based on these findings, the present report aims to provide an extensive overview of Helicobacter pylori infections, namely describing its involvement in triggering gastric cancer and the most common antimicrobials used in H. pylori eradication. Special attention is also given to medicinal plants and their corresponding extracts and isolated constituents used as anti-H. pylori agents and urease inhibitors. This review was performed by consulting the databases of PubMed, Web of Science, Embase, and Google Scholar (as a search engine); only full-text available articles were considered, and articles published from 2008 to 2018 were prioritized. The search strategy included the combination of following keywords: “Helicobacter pylori”, “anti-Helicobacter”, “medicinal plant”, “plant extract”, “essential oil”, “bioactive”, “phytochemical”, “antimicrobial”, and “eradication”.

2. Helicobacter pylori and Gastric Cancer

H. pylori infection has been implicated in the development of gastric cancer, a multifactorial disease and a leading cause of mortality. The risk factors for gastric cancer have been shown to include environmental factors and factors that influence host–pathogen interaction, as well as the complex interplay between these factors [31]. Modern lifestyle, high stress levels, smoking and excessive alcohol consumption, nutritional deficiencies, and prolonged use of non-steroidal anti-inflammatory drugs (NSAIDs) are amongst the most relevant etiological environmental factors [32].

This bacterial infection has been linked to the initiation of chronic gastritis that could later lead to adenocarcinoma of the intestine [33]. However, several mechanisms have been proposed to represent the involvement of H. pylori infection in tumorigenesis. Several bacterial virulence factors, such as the cytotoxin-associated gene A (CagA) protein, present in the DNA insertion element Cag pathogenicity island (CagPAI), were found to be of prominent importance in carcinogenesis [34]. Likewise, bacterial peptidoglycan can be delivered into gastric epithelial cells, where it activates a phosphoinositide 3-kinase (PI3K)-Akt pathway leading to cell proliferation, migration, and prevention of apoptosis [35]. Furthermore, H. pylori-induced gastric inflammation involves the cyclooxygenase-2 (COX2)/prostaglandin E2 (PGE2) pathway and inflammatory marker interleukin 1β (IL-1β), which are important factors triggering chronic active gastritis and
adenocarcinoma [31]. Studies have also shown that *H. pylori* infection-induced oxidative stress and DNA damage coupled with dysregulation of E-cadherin/β-catenin/p120 interactions also play critical roles in tumorigenesis [31]. Several environmental and dietary factors have also been suggested to modify *H. pylori*-induced adenocarcinoma [36]. Gastric adenocarcinoma is strongly influenced by dietary salt intake, with high salt intake aggravating tumorigenesis [37].

3. Antimicrobials for *H. pylori* Eradication

The success of *H. pylori* eradication markedly depends on the type and duration of treatment, patient compliance to therapy, and antibiotic resistance. For example, because it is difficult to achieve optimal eradication of *H. pylori* infection in patients with peptic ulcers, combinational regimens using two or three antibiotics in addition to a proton pump inhibitor or bismuth are often prescribed to achieve higher eradication rates and to prevent antibiotic resistance emergence [38,39]. These regimens, also known as triple therapies, have cure rates of around 85–90%. They are usually administered for a period of about 10–14 days, in which treatment regimens include the following: (A) bismuth subsalicylate, metronidazole, and tetracycline for 14 days; (B) omeprazole, amoxicillin, and clarithromycin for 10 days; and (C) lansoprazole, amoxicillin, and clarithromycin for either 10 or 14 days.

Unfortunately, the heightening of antimicrobial resistance has been associated with increases in the standard triple therapies failure to eradicate *H. pylori* infection [40]. Hence, research is focusing on developing potent and effective antibacterial regimens that will favor total eradication of the infection. Nonetheless, any eradication treatment comes with some degree of adverse effects, such as nausea, metallic taste, vomiting, skin rash, and diarrhea. Therefore, efforts are being channeled towards the development of effective treatments with few to no side effects.

In the Maastricht V/Florence Consensus Report, 43 experts from 24 countries provided recommendations on the basis of the best available evidence and relevance to the current therapeutic options of management of *H. pylori* infection in the various clinical scenarios [41].

4. Plant Extracts and Phytochemicals with Anti-*Helicobacter pylori* Activity

Considering that *H. pylori* infection has been associated with gastrointestinal diseases, including chronic gastritis, peptic ulcer, gastric carcinoma, and mucosa-associated lymphoid tissue lymphoma [42], and that, due to the widespread use of therapeutic agents for the eradication of this bacterium and associated-side effects, increasing rates of *H. pylori* strains with acquired resistance have been discovered. So, the urgent need for alternative has been rekindled and aided by the use of natural drugs [32].

Despite, the newly proposed and used tri-therapy regimens, the cost of acid suppressors and stomach protectors make it inaccessible to the majority of the population [43]. Naturally-derived drugs, including herbs, have been shown to display anti-*H. pylori* activities with minimal side effects, easy accessibility, and affordability [42,44]. In fact, many medicinal plants have been reported in the traditional management of gastrointestinal disorders. Many of these medicinal plants have gone through bioassays to assess their potency against *H. pylori*. Here, the anti-*H. pylori* activity of medicinal plants and isolated bioactive molecules is discussed [45].

Almost all plant parts have been tested for anti-*H. pylori* activity. Plant extract preparations include water (Table 1), essential oils (Table 2), or organic solvents, such as the following: ethanol (Table 3); methanol (Table 4); acetone (Table 5); chloroform (Table 6); petroleum ether (Table 7); methanol/water, ethanol/water, methanol/petroleum, and methanol/dichloromethane extracts (Table 8); and other plant extracts (Table 9).
The susceptibility of *H. pylori* isolates and strains to 543 extracts from 246 plant species was tested by disc diffusion, agar diffusion, agar dilution, and broth microdilution assays. Activity ranged from 1.56–100,000 µg/mL for minimal inhibitory concentration (MIC) and 7–42 mm for inhibition zone diameters (IZDs). However, disparities were observed among the methods used and the tested concentrations: some extracts were tested at very high concentrations (100,000 µg/mL) that might have resulted in biased conclusions. Though many plants (246 species) showed anti-*H. pylori* activity in vitro, very few have been screened for activity in animal models.

Organic extracts of *Carum carvi*, *Xanthium brasiliicum*, and *Trachyspermum copticum* have demonstrated antibacterial activity against 10 clinical isolates of *H. pylori* [46]. In addition, ethanolic extracts of *Cuminum cyminum* and propolis exhibited significant in vitro inhibitory effect against *H. pylori* and, therefore, could be considered a valuable support in the treatment of infection, even contributing to the development of new and safer agents for inclusion in anti-*H. pylori* therapy regimens [47]. Some popular plant species used in Brazilian cuisine and folk medicine in the treatment of gastrointestinal disorders were also investigated for their antibacterial effects, among which *Bixa orellana*, *Chamomilla recutita*, *Ilex paraguariensis*, and *Malva sylvestris* were the most effective against *H. pylori* [48].

Bioactive plant compounds were also tested for their anti-*H. pylori* potency (Table 10), namely those isolated from the *Allium sativum* (clove), *Convolvulus austro-aegyptiacus* (aerial parts), *Glycyrrhiza glabra* (roots), *Hydrastis canadensis* (rhizomes), *Sanguinaria canadensis* (rhizomes), and *Tinospora sagittata* (aerial parts) species. Berberine, a benzylisoquinoline alkaloid, isolated from *Hydrastis canadensis*, revealed the lowest MIC value (0.78 µg/mL), being therefore considered the most effective bioactive compound, followed by diallyl tetrasulfide (3–6 µg/mL), allicin (4 µg/mL), and palmatine (3.12–6.25 µg/mL) isolated from *Allium sativum* and *Tinospora sagittata*, respectively.
Table 1. Plant aqueous extracts with anti-*Helicobacter pylori* activity.

| Species                                      | Family          | Parts                          | Anti-*H. pylori* Potency            | Ref.   |
|----------------------------------------------|-----------------|--------------------------------|------------------------------------|--------|
| *Acacia nilotica* (L.) Delile                | *Leguminosae*   | Flowers                        | MIC = 8–64 µg/mL                   | [49]   |
| *Adhatoda vasica* Nees                      | *Acanthaceae*   | Whole plant                    | MIC = 16–512 µg/mL                 | [49]   |
| *Alepidea anatombica* Eckl. and Zeyh        | *Apiaceae*      | Roots/Rhizomes                 | IZD = 8.0 ± 8.2 mm                 | [50,51]|
| *Amphipterygium adstringens* (Schldtl.) Standl. | *Anacardiaceae* | Aerial parts                   | MIC = 62.5–125 µg/mL               | [52]   |
| *Annona cherimola* Mill.                    | *Annonaceae*    | Leaves/Stem                    | MIC = 125 µg/mL                    | [52]   |
| *Artemisia ludoviciana* Nutt. subsp. mexicana (Willd. ex Spreng.) Fernald | *Compositae*    | Leaves/stems                   | MIC = 125 µg/mL                    | [52]   |
| *Buddleia perfoliata* Kunth                 | *Scrophulariaceae* | Aerial parts                | MIC = 500 µg/mL                    | [52]   |
| *Calandrinia ciliata* (Ruiz and Pav.) DC. (cited as Calandrinia micrantha Schldtl.) | *Portulacaceae* | Leaves/Stems                   | MIC = 1000 µg/mL                   | [52]   |
| *Calotropis procera* (Aiton) W.T. Aiton     | *Apocynaceae*   | Leaves                         | MIC = 16–256 µg/mL                 | [49]   |
| *Cassiphoineum amphostenon* (Kunze ex Klotzsch) Fée | *Polypoideae*  | Flowers                        | MIC = 8–256 µg/mL                  | [49]   |
| *Casuarina equisetifolia* L.                | *Cassidineae*   | Aerial parts                   | MIC = 1000 µg/mL                   | [52]   |
| *Chenopodium incisum* Poir. (cited as *Teloxys graveolens* (Willd.) W. A. Weber) | *Amaranthaceae* | Aerial parts                   | MIC = 250 µg/mL                    | [52]   |
| *Cichorium intybus* L.                      | *Asteraceae*    | Root                           | IZD < 9 mm                         | [47]   |
| *Cinnamomum zeylanicum* Blume               | *Lauraceae*     | Bark                           | IZD < 9 mm                         | [47]   |
| *Cistus laurifolius* L.                     | *Cistaceae*     | Flowers                        | MIC = 62.5–125 µg/mL               | [54]   |
| *Citrus reticulata* Blanco                  | *Rutaceae*      | Fruit shell                    | MIC = 100 µg/mL                    | [55]   |
| *Cocculus hirsutus* (L.) Diels.             | *Menispermeae*  | Leaves                         | IZD = 22 mm (200–1000 µg/mL)       | [56]   |
| *Combretum molle* R. Br. Ex G. Don          | *Combretaceae*  | Bark                           | IZD = 2.7 ± 5.5 mm                 | [50,51]|
| *Coriandrum sativum* L.                     | *Apiaceae*      | Seed                           | IZD = 9 mm; MIC = 1.25–5 mg/mL     | [47]   |
| *Corydalis yanhusuo* W.T. Wang              | *Papaveraceae*  | Stem                           | MIC = 100 µg/mL                    | [55]   |
| *Cuminum cyminum* L.                        | *Apiaceae*      | Seed                           | IZD < 9 mm                         | [47]   |
| *Cuphea aequipetala* Cav.                   | *Lythraceae*    | Aerial parts                   | MIC = 125 µg/mL                    | [52]   |
| *Cynara scolymus* L.                        | *Asteraceae*    | Leaves                         | MIC = 125 µg/mL                    | [52]   |
| *Cytocarpa procera* Kunth                   | *Anacardiaceae* | Bark                           | MIC = 250 µg/mL                    | [52]   |
### Table 1. Cont.

| Species | Family | Parts | Anti-\textit{H. pylori} Potency | Ref. |
|---------|--------|-------|---------------------------------|------|
| Desmos cochinchinensis Lour. | Annonaceae | Leaves | IZD = 10.0 ± 0.6 mm (240 \( \mu \text{g/disc} \)) | [59] |
| \textit{Dysphania ambrosioides} (L.) Mosyakin and Clemants (cited as \textit{Teloxys ambrosioides} (L.) W. A. Weber) | Amaranthaceae | Aerial parts | MIC = 1000 \( \mu \text{g/mL} \) | [52] |
| Elettaria cardamomum (L.) Maton. | Zingiberaceae | Seeds | IZD < 9 mm | [47] |
| Eurynga caroliniæ F. Delaroche | Apicaeae | Aerial parts | MIC = 1000 \( \mu \text{g/mL} \) | [52] |
| Eugenia Caryophyllata Thunb | Myrtaceae | Flower | MIC = 60 \( \mu \text{g/mL} \) | [55] |
| Eupatorium petiolare Moc. ex DC. | Compositae | Aerial parts | MIC = 500 \( \mu \text{g/mL} \) | [52] |
| Fagoniaar abica L. | Zygophyllaceae | Whole plant | MIC = 16–256 \( \mu \text{g/mL} \) | [49] |
| \textit{Foeniculum vulgare} Mill. var. dulce DC | Apicaeae | Seed | IZD < 9 mm; MIC = 5–10 mg/mL | [47] |
| Fritillaria thunbergii Miq. | Liliaceae | Stem | MIC = 40 \( \mu \text{g/mL} \) | [55] |
| \textit{Garcinia kola} Heckel | Guttiferae | Seeds | IZD = 1.0 ± 2.6 mm | [50, 51] |
| Geum iranicum Khatamsaz | Rosaceae | Root | IZD = 24–35 mm (100 \( \mu \text{g/mL} \)) | [60] |
| \textit{Gnaphalium canescens} DC. | Compositae | Aerial parts | MIC = 500 \( \mu \text{g/mL} \) | [52] |
| \textit{Grindelia inuloides} Willd. | Compositae | Aerial parts | MIC = 500 \( \mu \text{g/mL} \) | [52] |
| \textit{Hesperozygis marifolia} Epling | Lamiaceae | Aerial parts | MIC = 500 \( \mu \text{g/mL} \) | [52] |
| \textit{Heterotheca inuloides} Cass. | Compositae | Aerial parts | MIC = 500 \( \mu \text{g/mL} \) | [52] |
| \textit{Juniperus communis} L. | Compositae | Aerial parts | MIC = 500 \( \mu \text{g/mL} \) | [52] |
| \textit{Larrea tridentata} (Sessé and Moc. ex DC.) Coville | Zygophyllaceae | Aerial parts | MIC = 500 \( \mu \text{g/mL} \) | [52] |
| \textit{Ligusticum striatum} DC (cited as \textit{Ligusticum chuanxiong} Hort.) | Apiaceae | Root | MIC = 100 \( \mu \text{g/mL} \) | [55] |
| \textit{Lippia graveolens} Kunth (cited as \textit{Lippia berlandieri} Schauer) | Verbenaceae | Aerial parts | MIC = 1000 \( \mu \text{g/mL} \) | [52] |
| \textit{Ludwigia repens} J. R. Forst. | Onagraceae | Aerial parts | MIC = 125 \( \mu \text{g/mL} \) | [52] |
| \textit{Machaeranthera riparia} (Kunth) A.G. Jones | Compositae | Aerial parts | MIC = 1000 \( \mu \text{g/mL} \) | [52] |
| \textit{Machaeranthera tanacetifolia} (Kunth) Nees | Compositae | Aerial parts | MIC = 1000 \( \mu \text{g/mL} \) | [52] |
| \textit{Mentha × piperita} L. | Lamiaceae | Leaves | IZD < 9 mm | [47] |
| \textit{Mirabilis jalapa} L. | Nyctaginaceae | Aerial parts | MIC = 250 \( \mu \text{g/mL} \) | [52] |
| \textit{Monarda citriodora} var. austromontana (Epling) B. L. Turner (cited as \textit{Monarda austromontana} Epling) | Lamiaceae | Aerial parts | MIC = 500 \( \mu \text{g/mL} \) | [52] |
| \textit{Olea europaea} L. | Oleaceae | Leaves/Stem | MIC = 125 \( \mu \text{g/mL} \) | [52] |
| \textit{Oregano vulgare} L. | Lamiaceae | Leaves | IZD = 25 mm; MIC = 0.6–2.5 mg/mL | [47] |
| \textit{Orthosiphon aristatus} (Blume) Miq. (cited as \textit{Orthosiphon stamineus} Benth) | Lamiaceae | Leaves | IZD = 9.0 ± 1.3 mm (240 \( \mu \text{g/disc} \)) | [59] |
| | Lamiaceae | Stem | IZD = 8.0 ± 0.1 mm (240 \( \mu \text{g/disc} \)) | [59] |
Table 1. Cont.

| Species                          | Family     | Parts       | Anti-\textit{H. pylori} Potency | Ref. |
|----------------------------------|------------|-------------|---------------------------------|------|
| \textit{Peumus boldus} Mol.      | Monimiaceae| Leaves      | $>1500$ µg/mL                   | [61] |
| \textit{Plantago major} L.       | Plantaginaceae| Aerial parts| MIC = 1000 µg/mL                | [52] |
| \textit{Priva grandiflora} (Ortega) Moldenke | Verbenaceae| Aerial parts| MIC = 250 µg/mL                 | [52] |
| \textit{Prunus avium} L.         | Rosaceae   | Peduncles   | IZD = 9 mm; MIC = 5–10 mg/mL    | [47] |
| \textit{Rosmarinus officinalis} L. | Lamiaceae | Leaves      | IZD < 9 mm                      | [47] |
| \textit{Ruta chalepensis} L.     | Rutaceae   | Leaves      | MIC = 1000 µg/mL                | [52] |
| \textit{Salvia officinalis} L.   | Lamiaceae  | Leaves      | IZD = 10 mm; MIC = 1.25–10 mg/mL| [47] |
| \textit{Sclerocarya birrea} A. Rich Hochst | Anacardiaceae| Stem bark  | MIC = 0.16–2.5 mg/mL            | [50,51] |
| \textit{Tagetes lucida} Cav.     | Compositae | Aerial parts| MIC = 500 µg/mL                 | [65] |
| \textit{Tecomia stans} (L.) Juss. ex Kunth | Bignoniaceae| Aerial parts| MIC = 1000 µg/mL                | [52] |
| \textit{Terminalia catappa} L.   | Combretaceae| Aerial parts| MIC = 125 µg/mL                 | [62] |
| \textit{Terminalia chebula} Retz | Combretaceae| Fruit       | MIC = 125 mg/mL                 | [63] |
| \textit{Thymus serpyllum} L.     | Lamiaceae  | Aerial parts| IZD = 10 mm; MIC = 1.25–10 mg/mL| [47] |
| \textit{Tillandsia usneoides} L. | Bromeliaceae| Aerial parts| MIC = 1000 µg/mL                | [52] |
| \textit{Tinospora sagittata} Gagnep. | Menispermaceae| Root       | MIC = 100 µg/mL                 | [55] |
| \textit{Tithonia diversifolia} (Hemsl.) A.G. | Compositae| Aerial parts| MIC = 500 µg/mL                 | [52] |
| \textit{Verbena carolina} L.     | Verbenaceae| Aerial parts| MIC = 62.5–125 µg/mL            | [52] |
| \textit{Zingiber officinale} Roscoe | Zingiberaceae| Rhizome  | IZD = 9 mm; MIC = 2.5–3 mg/mL   | [47] |

MIC, minimal inhibitory concentration; IZD, inhibition zone diameter; MBC, minimal bactericidal concentration.

Table 2. Plant essential oils with anti-\textit{H. pylori} activity.

| Species                          | Family     | Parts       | Anti-\textit{H. pylori} Potency | Ref. |
|----------------------------------|------------|-------------|---------------------------------|------|
| \textit{Abies mariesii} Mast. (cited as \textit{Abies maritima}) | Pinaceae   | Pine        | IZD = 22 ± 2 mm (500 µg/disc)   | [64] |
| \textit{Allium sativum} L.       | Amaryllidaceae| Cloves     | IZD = 14 ± 1 mm (500 µg/disc)   | [64] |
| \textit{Artemisia dracunculus} L. | Compositae | Tarragon    | 8–32 µg/mL                      | [65] |
| \textit{Carum carvi} L.          | Apiaceae   | Caraway     | IZD = 7 ± 0 mm (500 µg/disc)    | [64] |
| \textit{Carum carvi} L.          | Apiaceae   | Caraway     | IZD = 12 ± 0 mm (500 µg/disc)   | [64] |
Table 2. Cont.

| Species                          | Family    | Parts           | Anti-*H. pylori* Potency                      | Ref. |
|----------------------------------|-----------|-----------------|---------------------------------------------|------|
| *Cinnamomum zeylanicum* Blume    | Lauraceae | Bark            | MIC = 0.3 µL/mL; IZD = 24.8 mm              | [66] |
| *Cistus ladanifer* L.           | Cistaceae | Cistus          | IZD = 10 ± 1 mm (500 µg/disc)               | [64] |
| *Citrus aurantium* L.           | Rutaceae  | Orange blossom  | IZD = 12 ± 0 mm (500 µg/disc)               | [64] |
| *Citrus limon* (L.) Burm. f.    | Rutaceae  | Lemon           | IZD = 16 ± 0 mm (500 µg/disc)               | [64] |
| *Citrus paradise* Macfady        | Rutaceae  | Grapefruit      | IZD = 13 ± 0.5 mm (500 µg/disc)             | [64] |
| *Cupressus sempervirens* L.     | Cupressaceae | Cypress        | IZD = 19 ± 3.5 mm (500 µg/disc)             | [64] |
| *Cymbopogon citratus* (DC.) Stapf | Poaceae   | Lemongrass      | IZD = 17 ± 0.5 mm (500 µg/disc)             | [64] |
| *Daucus carota* L.              | Apiaceae  | Carrot seed     | IZD = 16 ± 1.5 mm (500 µg/disc)             | [64] |
| *Dittrichia viscosa* (L.) Greuter subsp. revoluta | Asteraceae | Aerial parts | IZD = 10 ± 1 mm (500 µg/disc)               | [64] |
| *Eucalyptus globulus* L.        | Myrtaceae | Eucalyptus      | IZD = 12 ± 10 mm (500 µg/disc)              | [64] |
| *Eugenia caryophyllus* (Spreng.) Bullock and S. G. Harrison | Myrtaceae | Clove-bud       | IZD = 13 ± 2.5 mm (500 µg/disc)             | [64] |
| *Heracleum persicum* L.         | Apiaceae  | Fruits          | >88% inhibition (0.3 µL/mL)                 | [66] |
| *Juniperus communis* L.         | Cupressaceae | Berry          | IZD = 14 ± 0.5 mm (500 µg/disc)             | [64] |
| *Leptospermum scoparium* J. R. Forst and G. Forst | Myrtaceae | Manuka          | IZD = 23 ± 3 mm (500 µg/disc)               | [64] |
| *Aloysia citriodora* Palau (cited as *Lippia citriodora*) | Verbenaceae | Aerial parts | IZD = 29 ± 2 mm (500 µg/disc)               | [64] |
| *Matricaria chamomilla* L. (cited as *Matricaria recutita*) | Compositae | Flowers        | IZD = 15 ± 10 mm (500 µg/disc)              | [64] |
| *Melaleuca alternifolia* Cheel. | Myrtaceae | Tea tree        | IZD = 9 ± 0.3 mm (500 µg/disc)              | [64] |
Table 2. Cont.

| Species                  | Family      | Parts          | Anti-\textit{H. pylori} Potency          | Ref. |
|--------------------------|-------------|----------------|----------------------------------------|------|
| \textit{Ocimum basilicum} L. | Lamiaceae   | Aerial parts   | IZD = 9 ± 0.3 mm (500 µg/disc)          | [64] |
| \textit{Origanum vulgare} L. | Lamiaceae   | Leaves         | IZD = 19 ± 4 mm (500 µg/disc)           | [64] |
| \textit{Pimpinella anisum} L. | Apiaceae    | Anise          | IZD = 12 ± 10 mm (500 µg/disc)          | [64] |
| \textit{Salvia sclarea} L. | Lamiaceae   | Aerial parts   | IZD = 10 ± 2 mm (500 µg/disc)           | [64] |
| \textit{Salvia officinalis} L. | Lamiaceae   | Leaves         | IZD = 10 ± 2 mm (500 µg/disc)           | [64] |
| \textit{Sassafra} sieckii Siebold | Lauraceae   | Aerial parts   | IZD = 10 ± 2 mm (500 µg/disc)           | [64] |
| \textit{Satureja montana} L. | Lamiaceae   | Savory         | IZD = 10 ± 2 mm (500 µg/disc)           | [64] |
| \textit{Syzygium aromaticum} (L.) Merr. and L. M. Perry | Myrtaceae   | Buds           | >88% inhibition (0.3 µL/mL)             | [66] |
| \textit{Thymus vulgaris} L. | Lamiaceae   | Thyme          | IZD = 15 ± 5 mm (500 µg/disc)           | [64] |
| \textit{Thymus zygis} L. | Lamiaceae   | Red thyme      | IZD = 12 ± 10 mm (500 µg/disc)          | [64] |
| \textit{Zataria multiflora} Boiss. | Lamiaceae   | Aerial parts   | IZD = 19 ± 0.5 mm (500 µg/disc)         | [64] |

* Initial population of 8.52 ± 0.30 log10 colony forming unit (CFU)/mL reduced to 7.67 ± 0.22 log10 CFU/mL; MIC, minimal inhibitory concentration; IZD, inhibition zone diameter.

Table 3. Plant ethanolic extracts with anti-\textit{H. pylori} activity.

| Species                          | Family      | Parts          | Anti-\textit{H. pylori} Potency          | Ref. |
|----------------------------------|-------------|----------------|----------------------------------------|------|
| \textit{Abrus cantoniensis} Bge. | Leguminosae | Aerial parts   | MIC = 40 µg/mL                          | [55] |
| \textit{Alepidea Amatymbica} Eckl. and Zeyh | Apiaceae   | Roots/rhizomes | IZD = 6.7 ± 6.7 mm                      | [50,51] |
| \textit{Anomum villosum} Lour.   | Zingiberaceae | Fruit         | MIC = 100 µg/mL                         | [55] |
| \textit{Bixa orellana} L.        | Bixaceae    | Seed           | MIC = 625–1250 µg/mL                    | [48] |
| \textit{Bupleurum chinense} DC.  | Apiaceae    | Aerial parts   | MIC = 60 µg/mL                          | [53] |
| \textit{Chamomilla recutita} (L.) Rauschert | Compositae | Inflorescences | MIC ≤ 625 µg/mL                         | [48] |
| \textit{Cichorium intybus} L.    | Asteraceae  | Root           | IZD = 12 mm; MIC = 1.25–10 mg/mL        | [47] |
| \textit{Cinnamomum zeylanicum} Blume | Lauraceae   | Bark           | IZD = 20 mm; MIC = 1.25–5 mg/mL         | [47] |
| \textit{Citrus reticulata} Blanco | Rutaceae    | Fruit shell    | MIC = 60 µg/mL                          | [55] |
| \textit{Combretum molle} R. Br. Ex G. Don | Combretaceae | Bark          | IZD = 12.9 ± 4.7 mm                     | [50,51] |
### Table 3. Cont.

| Species                        | Family               | Parts               | Anti-\(H.\) pylori Potency | Ref.   |
|-------------------------------|----------------------|---------------------|-----------------------------|--------|
| Convolvulus austro-aegyptiacu Abdallah and Saad | Convolvulaceae       | Aerial parts        | MIC = 100–200 µg/mL         | [67]   |
| Coriandrum sativum L.         | Apiaceae             | Seed               | IZD = 12 mm; MIC = 5–10 mg/mL | [47]   |
| Coryalis yanhusuo W.T. Wang   | Papaveraceae         | Stem               | MIC = 60 µg/mL              | [55]   |
| Cuminum cyminum L.            | Apiaceae             | Seed               | IZD = 0.075–0.6 mg/mL       | [47]   |
| Elettaria cardamomum (L.) Maton. | Asteraeae            | Leaves             | IZD = 25 mm; MIC = 0.6–2.5 mg/mL | [47]   |
| Eugenia caryophyllata Thunb   | Myrtaceae            | Flower             | MIC = 40 µg/mL              | [55]   |
| Foeniculum vulgare Mill. var. dulce DC | Apiaceae             | Seed               | IZD < 9 mm                  | [47]   |
| Fritillaria thunbergii Miq.   | Liliaceae            | Stem               | MIC = 40 µg/mL              | [55]   |
| Garcinia kola Heckel          | Guttiferae           | Seeds              | MIC = 0.63–5 mg/mL; IZD = 9.2 ± 7.2 mm | [30,51] |
| Hippophae rhamnoides L.       | Elaeagnaceae         | Leaves             | MIC = 60 µg/mL              | [55]   |
| *Ilex paraguariensis* A. St.-Hil. | Aquifoliaceae       | Green leaves       | MIC ≤ 625–5000 µg/mL        | [48]   |
| Juniperus communis L.         | Cupressaceae         | Berry              | IZD = 10 mm; MIC = 1.25–10 mg/mL | [47]   |
| Ligusticum striatum DC (cited as *Ligusticum chuanxiong*) | Apiaceae             | Green leaves       | MIC ≤ 625–5000 µg/mL        | [48]   |
| Lysimachia christinae Hance   | Prinulacae           | Whole plant        | MIC = 100 µg/mL             | [55]   |
| Magnolia officinalis Rehd. et Wils. | Magnoliaceae       | Bark               | MIC = 60 µg/mL              | [55]   |
| Malva sylvestris L.           | Malvaceae            | Leaves and          | MIC ≤ 625–5000 µg/mL        | [48]   |
| Melia azedarach L. (cited as *Melia toosendan*) | Meliaceae           | Fruit              | MIC = 100 µg/mL             | [55]   |
| Mentha × piperita L.          | Lamiaceae            | Leaves             | IZD < 9 mm                  | [47]   |
| Piper longum L.               | Piperaceae           | Spike              | MIC = 100 µg/mL             | [55]   |
| Prunus aruti L.               | Rosaceae             | Peduncles          | IZD = 10 mm; MIC = 1.25–10 mg/mL | [47]   |
| Rosmarinus officinalis L.     | Lamiaceae            | Leaves             | IZD = 20 mm; MIC = 1.25–10 mg/mL | [47]   |
| Salvia officinalis L.         | Lamiaceae            | Leaves             | IZD = 14 mm; MIC = 1.25–5 mg/mL | [47]   |
| Saussurea costus (Falc.) Lipsch. (cited as *Saussurea lappa*) | Compositae           | Root               | MIC = 40 µg/mL              | [55]   |
| Schisandra chinensis Baill.   | Schisandraceae       | Fruit              | MIC = 60 µg/mL              | [55]   |
| Sclerocarya birrea A. Rich Hochst | Anacardiaceae       | Stem bark          | IZD = 3.3 ± 5.0 mm          | [30,51] |
| Thymus serpyllum L.           | Lamiaceae            | Aerial parts       | IZD = 22 mm; MIC = 1.25–10 mg/mL | [47]   |
| Tinospora sagittata Gagnep.   | Menispermaceae       | Aerial parts       | MIC/MBC = 6250 µg/mL        | [42]   |
| Trigonella foenum-graecum L.  | Leguminosae          | Seed               | MIC = 40 µg/mL              | [55]   |
| Zingiber officinale Roscoe    | Zingiberaceae        | Rhizome            | IZD = 25 mm; MIC = 0.075–0.6 mg/mL | [47]   |

MIC, minimal inhibitory concentration; IZD, inhibition zone diameter.
Table 4. Plant methanolic extracts with anti-\textit{H. pylori} activity.

| Species                              | Family         | Parts            | \textit{H. pylori} Potency | Ref.       |
|--------------------------------------|----------------|------------------|---------------------------|------------|
| \textit{Acacia nilotica} (L.) Delile   | Leguminosae    | Leaves           | MIC = 8–128 \textmu g/mL  | [49]       |
|                                       |                | Flowers          | MIC = 8–64 \textmu g/mL   | [49]       |
| \textit{Acanthus montanus} (Nees) T. Anders | Acanthaceae    | Leaves stalk     | IZD = 6–22 mm (25 \textmu g/disc) | [68]       |
| \textit{Achillea millefolium} L.      | Compositae     | Aerial parts     | MIC = 1.56–100 \textmu g/mL | [69]       |
| \textit{Adhatoda vasica} Nees         | Compositae     | Whole plant      | MIC = 64–512 \textmu g/mL  | [49]       |
| \textit{Aframomum pruinoseum} Gagnepain | Zingiberaceae  | Seed             | MIC = 128 \textmu g/mL     | [70]       |
|                                       |                |                  | IZD = 6–22 mm (25 \textmu g/disc); | [68]       |
| \textit{Ageratum conyzoides} L.       | Compositae     | Aerial parts     | MIC = 1.56–100 \textmu g/mL | [69]       |
|                                       |                |                  | MBC = 195–12,500 \textmu g/mL | [72]       |
| \textit{Alchemilla fissa} Günther and Schummel | Rosaceae       | Aerial parts     | MIC = 4–32 \textmu g/mL    | [71]       |
| \textit{Alchemilla glabra} Neygenf.    | Rosaceae       | Aerial parts     | MIC = 4–32 \textmu g/mL    | [71]       |
| \textit{Alchemilla monticola} Opiz.    | Rosaceae       | Aerial parts     | MIC = 4–32 \textmu g/mL    | [71]       |
| \textit{Alchemilla viridisflora} Rothm. | Rosaceae       | Aerial parts     | MIC = 4–16 \textmu g/mL    | [71]       |
| \textit{Alchornea triplinervia} (Spreng.) Müll.Arg. | Euphorbiaceae  | Aerial parts     | MIC = 250 \textmu g/mL     | [72]       |
| \textit{Ampelidea amatymbica} Eckl. and Zeyh | Apiaceae       | Roots/rhizomes   | IZD = 6.1 ± 6.4 mm         | [50,51]    |
| \textit{Alpinia galanga} (L.) Willd. (cited as \textit{Languas galanga}) | Zingiberaceae  | Tuber            | IZD = 21.5 ± 1.9 mm (240 \textmu g/disc) | [59]       |
| \textit{Anoda cristata} (L.) Schltdl. Standl. | Malvaceae      | Aerial parts     | MIC = 250 \textmu g/mL     | [52]       |
| \textit{Artemisia ludoviciana} Nutt. subsp. mexicana (Willd. ex Spreng.) Fernald | Compositae     | Leaves/stem      | MIC = 500 \textmu g/mL     | [52]       |
| \textit{Aulotandria kamerunensis} (Loes) | Apocynaceae    | Aerial parts     | MIC = 128–512 \textmu g/mL | [73]       |
| \textit{Bryophyllum pinnatum} (Lam.) Kurz | Crassulaceae   | Leaves           | MBC = 256 \textmu g/mL     | [74]       |
| \textit{Calandrinia ciliata} (Ruiz and Pav.) DC. (cited as \textit{Calandrinia micrantha}) | Portulacaceae  | Leaves/Stem      | MIC = 250 \textmu g/mL     | [52]       |
| \textit{Calopilygium adstringens} (Schltdl.) Standl. | Anacardiaceae  | Aerial parts     | MIC = 31 \textmu g/mL      | [75]       |
| \textit{Calotropis gigantea} (L.) W.T. Aiton | Apocynaceae    | Leaves           | IZD = 7–8 mm (62.5–1000 \textmu g/disc) | [59]       |
| \textit{Calotropis procera} W.T. Aiton | Apocynaceae    | Flowers          | IZD = 9.8 ±1.2 mm (240 \textmu g/disc) | [59]       |
| \textit{Capsella bursa-pastoris} (L.) Medik. | Brassicaceae   | Aerial parts     | MIC = 64–256 \textmu g/mL  | [49]       |
| \textit{Carum carvi} L.               | Apiaceae       | Seeds            | MIC = 100 \textmu g/mL     | [69]       |
| \textit{Casuarina equisetifolia} L.   | Casuarinaceae  | Fruit            | MIC = 128–512 \textmu g/mL | [49]       |
| \textit{Centella asiatica} (L.) Urb.  | Apiaceae       | Whole plant      | IZD = 13.0 ± 0.9 mm (240 \textmu g/disc) | [59]       |
| Species                                      | Family          | Parts          | Anti-\( H. pylori \) Potency                  | Ref. |
|----------------------------------------------|-----------------|----------------|----------------------------------------------|------|
| Chenopodium incisum Poir. (cited as Teloxyx graveolens) | Amaranthaceae   | Aerial parts   | MIC = 62.5 µg/mL                              | [52] |
| Chromolaena odorata (L.) R.M. King and H. Rob. | Asteraceae      | Leaves         | IZD = 25.3 ± 1.6 mm (240 µg/disc)             | [59] |
| Cistus laurifolius L.                         | Cistaceae       | Flowers        | MIC = 62.5–125 µg/mL                          | [54] |
| Colubrina asiatica (L.) Brongn.               | Rhamnaceae      | Leaves         | IZD = 16.3 ± 2.1 mm (240 µg/disc)             | [59] |
| Combretum molle R. Br. Ex G. Don              | Combretaceae    | Bark           | IZD = 13.1 ± 5.3 mm                           | [50,51] |
| Cosmos caudatus Kunth                        | Asteraceae      | Leaves         | IZD = 23.0 ± 0.9 mm (240 µg/disc)             | [59] |
| Cuminum cyminum L.                           | Apiaceae        | Seed           | MIC = 100 µg/mL                               | [69] |
| Curcuma longa L.                              | Zingiberaceae   | Rhizome        | MIC = 12.5–100 µg/mL                          | [69] |
| Curcuma longa L./Zingiber officinale L.       |                 |                |                                              |      |
| Cymbopogon citratus (DC.) Stapf              | Poaceae         | Aerial parts   | MIC = 31.2 µg/mL                              | [52] |
| Cytocarpa procera Kunth                      | Compositae      | Bark           | MIC = 62.5 µg/mL                              | [58] |
| Dysphania ambrosioides (L.) Mosyakin and Clements (cited as Teloxyx ambrosioides) | Amaranthaceae   | Aerial parts   | MIC = 250–500 µg/mL                           | [52] |
| Elettaria cardamomum (L.) Maton.             | Zingiberaceae   | Seed           | MIC = 3.125-100 µg/mL                         | [69] |
| Emilia coccinea (Sims) G. Don                | Compositae      | Whole plant    | IZD = 6–22 mm (25 µg/disc)                    | [68] |
| Eryngium carinatum F. Delaroche              | Apiaceae        | Aerial parts   | MIC = 31.2 µg/mL                              | [52] |
| Eryngium foetidium L.                        | Apiaceae        | Whole plant    | IZD = 6–18 mm (25 µg/disc)                    | [68] |
| Eucalyptus terebelliana F. Muell.            | Myrtaceae       | Leaves         | MIC = 64–512 µg/mL                            | [73] |
| Eupatorium petiolare Moc. ex DC.             | Compositae      | Aerial parts   | MIC = 12.5–200 µg/mL                          | [76] |
| Euphorbia hirta L.                           | Euphorbiaceae   | Whole plant    | IZD = 6–18 mm (25 µg/disc)                    | [68] |
| Euphorbia umbellata (Pax) Bruyns             | Euphorbiaceae   | Bark           | 44.6% inhibition (256 µg/mL)                  | [77] |
| Fagonia gabica L.                            | Zygophyllaceae  | Whole plant    | MIC = 32–256 µg/mL                            | [49] |
| Ficus deltoidea Jack                         | Apiales         | Leaves         | IZD = 12.0 ± 0.6 mm (240 µg/disc)             | [59] |
| Foeniculum vulgare Mill. var. dulce DC      | Compositae      | Seeds          | MIC = 50–100 µg/mL                            | [69] |
| Galinsoga ciliata (Raf.) S. F. Blake          | Compositae      | Leaves         | MIC = 128–512 µg/mL                           | [73] |
| Gentiana lutea L.                            | Gentianaceae    | Root           | MIC = 3.125–100 µg/mL                         | [69] |
| Ginkgo biloba L.                             | Ginkgoaceae     | Leaves         | MIC = 100 µg/mL                               | [69] |
| Glycerrhiza glabra L.                        | Leguminosae     | Root           | IDZ = 19 mm (10 mg/mL)                        | [78] |
| Species                               | Family       | Parts       | Anti- *H. pylori* Potency | Ref. |
|---------------------------------------|--------------|-------------|--------------------------|-----|
| Gnaphalium canescens DC.              | Compositae   | Aerial parts| MIC = 62.5 µg/mL          | [52]|
| Grindelia inuloides Willd.            | Compositae   | Aerial parts| MIC = 62.5 µg/mL          | [52]|
| Haplopappus spinulosus (Pursh) DC.    | Compositae   | Aerial parts| MIC = 125 µg/mL           | [52]|
| Hesperozygis marifolia Epling         | Lamiaceae    | Aerial parts| MIC = 62.5 µg/mL          | [52]|
| Heterotheca inuloides Cass.           | Compositae   | Aerial parts| MIC = 31.25 µg/mL         | [52]|
| Hibiscus rosa-sinensis L.             | Malvaceae    | Stem        | IZD = 13.7 ± 1.2 mm (240 µg/disc) | [59]|
|                                       |              | Leaves      | IZD = 14.3 ± 1.0 mm (240 µg/disc) | [59]|
| Hippocratea celastroides HBK          | Hippocrateace| Leaves      | MIC = 7.81–125 µg/mL      | [79]|
| Hydrastis canadensis L.               | Ranunculaceae| Rhizome     | MIC = 0.78–50 µg/mL       | [80]|
| Illicium verum Hook. f.               | Schisandraceae| Fruit      | MIC = 50–100 µg/mL        | [69]|
| Jatropha podagrica Hook.              | Euphorbiaceae| Stem        | IZD = 8.0 ± 0.7 mm (240 µg/disc) | [59]|
| Juniperus communis L.                 | Cupressaceae | Leaves      | MIC = 25–100 µg/mL        | [69]|
| Kaempferia galanga                    | Zingiberaceae| Leaves      | IZD = 46.0±0.1 mm (240 µg/disc) | [59]|
| Larrea tridentata (Sessé and Moc. ex DC.) Coville | Zygophyllaceae| Aerial parts| MIC = 62.5 µg/mL          | [52]|
| Lauris nobilis L.                     | Lauraceae    | Leaves      | MIC = 50–100 µg/mL        | [69]|
| Lavandula angustifolia Mill.          | Lamiaceae    | Flower      | MIC = 100–1000 µg/mL      | [69]|
| Limnocharis flava (L.) Buchenau       | Alismataceae | Leaves      | IZD = 11.0 ± 1.1 mm (240 µg/disc) | [59]|
| Lippia graveolens Kunth (cited as Lippia berlandieri) | Verbenaceae | Aerial parts| MIC = 31.2 µg/mL          | [52]|
| Lithraea molleoides (Vell.) Engl.     | Anacardiaceae| Aerial parts| MIC = 18–125 µg/mL        | [81]|
| Ludwigia repens J. R. Forst.          | Onagraceae   | Aerial parts| MIC = 500 µg/mL           | [52]|
| Lycopodium cernua (L.) Pic. Serm      | Lycopodiaceae| Whole plant | IZD = 16–22 mm (25 µg/disc); MBC = 195–12500 µg/mL | [68]|
| Machaeranthera parviflora A. Gray     | Compositae   | Aerial parts| MIC = 31.2 µg/mL          | [52]|
| Machaeranthera riparia (Kunth) A.G. Jones | Compositae  | Aerial parts| MIC = 62.5 µg/mL          | [52]|
| Machaeranthera tanacetifolia (Kunth) Nees | Compositae | Aerial parts| MIC = 125 µg/mL           | [52]|
| Marantodes pumilum (Blume) Kuntze (cited as Labisia pumila) | Primulaceae | Root        | IZD = 8.0 ± 0.5 mm (240 µg/disc) | [59]|
| Marrubium vulgare L.                  | Lamiaceae    | Leaves/stem | MIC = 31.2 µg/mL          | [52]|

Table 4. Cont.
| Species                                      | Family                  | Parts          | Anti-\(H. \text{pylori}\) Potency                  | Ref. |
|----------------------------------------------|-------------------------|----------------|---------------------------------|------|
| *Melastoma malabathricum* L. (blue variety) | Melastomataceae         | Leaves         | \(\text{IZD} = 25.7 \pm 0.8 \text{ mm} (240 \mu\text{g/disc})\) | [59] |
| *Melissa officinalis* L.                    | Lamiaceae               | Stem           | \(\text{IZD} = 18.0 \pm 0.6 \text{ mm} (240 \mu\text{g/disc})\) | [59] |
| *Mentha × piperita* L.                      | Lamiaceae               | Leaves         | \(\text{MIC} = 100 \geq 100 \mu\text{g/mL}\) | [59] |
| *Mimosa pudica* L.                          | Loganiaceae             | Leaves/Stem    | \(\text{MIC} = 500 \mu\text{g/mL}\) | [52] |
| *Mitrasacme indica* Wight (cited as *Mitrasacme alsinoides*) | Loganiaceae             | Leaves         | \(\text{IZD} = 14.2 \pm 1.9 \text{ mm} (240 \mu\text{g/disc})\) | [59] |
| *Neptunia oleracea* Lour.                   | Leguminosae             | Whole plant    | \(\text{IZD} = 13.3 \pm 2.3 \text{ mm} (240 \mu\text{g/disc})\) | [59] |
| *Ocimum basilicum* L.                       | Lamiaceae               | Leaves         | \(\text{MIC} = 100 \geq 100 \mu\text{g/mL}\) | [69] |
| *Origanum vulgare* L.                       | Lamiaceae               | Aerial parts   | \(\text{MIC} = 50–100 \mu\text{g/mL}\) | [69] |
| *Orthosiphon aristatus* (Blume) Miq. (cited as *Orthosiphon stamineus*) | Lamiaceae               | Leaves         | \(\text{IZD} = 22.0 \pm 2.4 \text{ mm} (240 \mu\text{g/disc})\) | [59] |
| *Parkia speciosa* Hassk.                    | Leguminosae             | Root Cortex    | \(\text{IZD} = 16.0 \pm 0.9 \text{ mm} (240 \mu\text{g/disc})\) | [59] |
| *Passiflora edulis* Sims (cited as *Passiflora incarnata*) | Passifloraceae          | Aerial parts   | \(\text{MIC} = 3.125–25 \mu\text{g/mL}\) | [69] |
| *Persicaria minor* (Huds.) Opiz (cited as *Polygonum minus*) | Polygonaceae            | Leaves         | \(\text{MIC} = 50–100 \mu\text{g/mL}\) | [69] |
| *Phlox subulata* L.                         | Scrophulariaceae        | Flowers        | \(\text{MIC} = 100 \geq 100 \mu\text{g/mL}\) | [59] |
| *Petroselinum crispum* (Mill.) Fuss         | Apiaceae                | Aerial parts   | \(\text{MIC} = 15.5 \pm 1.1 \text{ mm} (240 \mu\text{g/disc})\) | [59] |
| *Phyllanthus niruri* L.                     | Phyllanthaceae          | Whole plant    | \(\text{MIC} = 100 \geq 100 \mu\text{g/mL}\) | [59] |
| *Priva grandiflora* (Ortega) Moldenke       | Verbenaceae             | Aerial parts   | \(\text{MIC} = 25.0 \mu\text{g/mL}\) | [52] |
| *Psidium guajava* L.                        | Myrtaceae               | Leaves         | \(\text{MIC} = 250 \mu\text{g/mL}\) | [52] |
| *Quercus rugosa* Née                        | Fagaceae                | Leaves         | \(\text{MIC} = 125 \mu\text{g/mL}\) | [52] |
| Species                  | Family          | Parts          | Anti-*H. pylori* Potency | Ref.  |
|--------------------------|-----------------|----------------|-------------------------|-------|
| *Rosmarinus officinalis* L. | Lamiaceae       | Leaves         | MIC = 12.5–100 µg/mL    | [69]  |
| *Ruta chalepensis* L.     | Rutaceae        | Leaves         | MIC = 62.5 µg/mL        | [52]  |
| *Salvia officinalis* L.   | Lamiaceae       | Leaves         | MIC = 25–100 µg/mL      | [69]  |
| *Sanguinaria canadensis* L. | Papaveraceae   | Rhizome        | MIC = 12.5–50 µg/mL     | [80]  |
| *Scleria woodii var. ornata* (Cherm.) J. Schultze-Motel (cited as *Scleria striatonixa*) | Cyperaceae      | Root           | IZD = 6–30 mm (25 µg/disc); MIC = 63–1000 µg/mL; MBC = 195–12,500 µg/mL | [68]  |
| *Scleria verrucossa* (Wild) | Cyperaceae      | Root           | IZD = 4–20 mm (25 µg/disc) | [68]  |
| *Sclerocarya birrea* A. Rich Hochst | Anacardiaceae | Stem bark      | IZD = 3.0 ± 4.4 mm      | [50,51] |
| *Solanum torvum* Sw.     | Solanaceae      | Seed           | IZD = 17.3 ± 1.6 mm (240 µg/disc) | [59]  |
| *Tagetes lucida* Cav.     | Compositae      | Aerial parts   | MIC = 500 µg/mL         | [52]  |
| *Tanacetum partshenium* (L.) Sch. Bip. | Compositae | Aerial parts   | MIC = 62.5 µg/mL        | [52]  |
| *Tapingonchilos annuus* (Hassk.) K. Schum. | Costaceae       | Rhizome        | IZD = 6–18 mm (25 µg/disc) | [68]  |
| *Tecoma stans* (L.) Juss. ex Kunth | Bignoniaceae   | Aerial parts   | MIC = 500 µg/mL         | [52]  |
| *Tillandsia usneoides* L. | Menispermacae   | Stem           | IZD = 13.7 ± 2.7 mm (240 µg/disc) | [59]  |
| *Tinospora sinensis* (Lour.) Merr. (cited as *Tinospora cordifolia*) | Menispermacae   | Stem           | IZD = 13.7 ± 2.7 mm (240 µg/disc) | [59]  |
| *Tithonia diversifolia* (Hemsl.) A.G. | Compositae      | Aerial parts   | MIC = 62.5 µg/mL        | [52]  |
| *Verbena carolina* L.    | Verbenaceae     | Aerial parts   | MIC = 500–1000 µg/mL    | [52]  |
| *Zingiber officinale* Roscoe | Zingiberaceae  | Rhizome        | MIC = 6.25–50 µg/mL     | [69]  |

**Table 5.** Plant acetone extracts with anti-*H. pylori* activity.

| Species                  | Family          | Parts          | Anti-*H. pylori* Potency | Ref.  |
|--------------------------|-----------------|----------------|-------------------------|-------|
| *Acacia nilotica* (L.) Delile | Leguminosae    | Leaves         | MIC = 8–128 µg/mL       | [49]  |
| *Adhatoda vasica* Nees   | Acanthaceae     | Whole plant    | MIC = 16–512 µg/mL      | [49]  |
| *Aleuridea Amatymbica* Eckt. and Zeyh | Apiaceae | Roots/Rhizomes | IZD = 7.0 ± 6.5 mm     | [50,51] |
| *Bridelia micrantha* (Hochst.) Baill. | Phyllanthaceae | Bark           | IZD = 16–23 mm         | [53]  |
| *Calotropis procera* W.T. Aiton | Apocynaceae    | Leaves         | MIC = 32–256 µg/mL      | [49]  |

MIC, minimal inhibitory concentration; MBC, minimal bactericidal concentration; IZD, inhibition zone diameter.
Table 5. Cont.

| Species                      | Family          | Parts       | Anti-\(H.\) pylori Potency                                      | Ref.   |
|------------------------------|-----------------|-------------|---------------------------------------------------------------|--------|
| *Casuarina equisetifolia L.*  | Casuarinaceae   | Fruit       | \(\text{MIC} = 128.0–1024 \, \mu g/mL}\)                   | [49]   |
| *Cocculus hirsutus* (L.) Diels. | Menispermae   | Leaves      | \(\text{IZD = 22–24 mm (200–1000} \, \mu g/mL)\)     | [56]   |
| *Combretum molle* R. Br. Ex G. Don * | Combretaceae | Bark        | \(\text{MIC}_{50} = 0.08–1.25 \, \text{mg/mL; }\text{IZD = 10.7 \pm 4.7 mm; }\) | [50,51]|
| *Desmostachya bipinnata* (L.) Stapf. | Gramineae     | Whole plant | \(\text{MIC = 1.3 mg/mL}\)                           | [84]   |
| *Fagonia arabaica* L.        | Zygophylaceae  | Whole plant | \(\text{MIC = 16–128} \, \mu g/mL\)                       | [49]   |
| *Garcinia kola* Heckel       | Guttiferae     | Seeds       | \(\text{IZD = 8.8 \pm 5.2 mm}\)                          | [50,51]|
| *Sclerocarya birrea* A. Rich Hochst * | Anacardiaceae | Stem bark   | \(\text{MIC}_{50} = 0.06–1.25 \, \text{mg/mL; }\text{IZD = 14.7 \pm 2.5 mm}\) | [50,51]|

\* Exhibited remarkable bactericidal activity against \(H.\) pylori, killing more than 50% of the strains within 18 h at 4\( \times \) MIC and led to complete elimination within 24 h; MIC, minimal inhibitory concentration; \(\text{MIC}_{50}\), minimal inhibitory concentration required to inhibit 50% of cells growth; \(\text{IZD}\), inhibition zone diameter.

Table 6. Plant chloroform extracts with anti-\(H.\) pylori activity.

| Species                          | Family      | Parts       | Anti-\(H.\) pylori Potency                                      | Ref.   |
|----------------------------------|-------------|-------------|----------------------------------------------------------------|--------|
| *Calotropis gigantea* (L.) W.T. Aiton | Apocynaceae | Leaves      | \(\text{IZD = 14.0 \pm 0.9 mm (240} \, \mu g/disc)\)         | [59]   |
| *Cedrus libani* A. Rich          | Pinaceae    | Cones       | \(\text{MIC = 31.2} \, \text{kg/mL}\)                       | [54]   |
| *Centaurea solstitialis* L.      | Asteraceae  | Aerial parts | \(\text{MIC = 1.95} \, \mu g/mL\)                           | [54]   |
| *Centella asiatica* (L.) Urb.    | Apiaceae    | Whole plant | \(\text{IZD = 8.2 \pm 0.4 mm (240} \, \mu g/disc)\)         | [59]   |
| *Chromolaena odorata* (L.) R.M. King and H. Rob. | Asteraceae | Leaves      | \(\text{IZD = 27.5 \pm 1.0 mm (240} \, \mu g/disc)\)         | [59]   |
| *Cistus laurifolius* L.          | Cistaceae   | Flowers     | \(\text{MIC = 1.95} \, \mu g/mL\)                           | [54]   |
| *Colubrina asiatica* (L.) Brongn. | Rhamnaceae  | Leaves      | \(\text{IZD = 10.0 \pm 0.9 mm (240} \, \mu g/disc)\)         | [59]   |
| *Cosmos caudatus* Kunth          | Asteraceae  | Leaves      | \(\text{IZD = 11.7 \pm 0.5 mm (240} \, \mu g/disc)\)         | [59]   |
| *Cymbopogon citratus* (DC.) Stapf | Poaceae     | Stem        | \(\text{IZD = 18.0 \pm 1.4 mm (240} \, \mu g/disc)\)         | [59]   |
| *Derris trifoliata* Lour.        | Leguminosae | Stem        | \(\text{MIC}_{50} = 2 \, \mu g/mL}\)                       | [59]   |
| \(\text{MIC}_{90} = 4 \, \text{mg/L}\) |             |             | \(\text{IZD = 38.0 \pm 1.0 mm (240} \, \mu g/disc)\)         | [59]   |
| *Desmos cochinchinensis* Lour.   | Annonaceae  | Leaves      | \(\text{IZD = 30.0 \pm 2.1 mm (240} \, \mu g/disc)\)         | [59]   |
| *Desmostachya bipinnata* (L.) Stapf. | Gramineae  | Whole plant | \(\text{MIC = 5} \, \text{mg/mL}\)                       | [84]   |
| *Eucalyptus camaldulensis* Dehnh | Myrtaceae   | Stem bark   | \(\text{MIC = 25–100} \, \mu g/mL\)                       | [76]   |
| *Eucalyptus tereticornis* Sm.    | Myrtaceae   | Leaves      | \(\text{MIC = 50} \, \mu g/mL\)                           | [76]   |
| Species                                      | Family            | Parts               | Anti-*H. pylori* Potency | Ref. |
|---------------------------------------------|-------------------|---------------------|-------------------------|------|
| *Eucalyptus torelliana* F. Muell.           | Myrtaceae         | Leaves              | MIC = 25–400 µg/mL      | [76] |
| *Ficus deltoidea* Jack                      | Moraceae          | Leaves              | IZD = 10.0 ± 0.6 mm (240 µg/disc) | [59] |
| *Heterotheca inuloides* Cass.               | Composite         | Leaves              | IZD = 11.2 ± 1.2 mm (240 µg/disc) | [59] |
| *Hypericum perforatum* L.                   | Hypericaceae      | Aerial parts        | MIC = 7.8–31.2 µg/mL    | [54] |
| *Jatropha podagrica* Hook.                  | Euphorbiaceae     | Leaves              | IZD = 10.0 ± 0.5 mm (240 µg/disc) | [59] |
| *Kaempferia galanga* Hook.                  | Zingiberaceae     | Stem                | IZD = 9.6 ± 0.6 mm (240 µg/disc) | [59] |
| *Alpinia galanga* (L.) Willd. (cited as *Languas galanga*) | Zingiberaceae     | Tuber               | IZD = 24.2 ± 1.6 mm (240 µg/disc) | [59] |
| *Hypericum perforatum* L.                   | Hypericaceae      | Aerial parts        | MIC = 7.8–31.2 µg/mL    | [54] |
| *Jatropha podagrica* Hook.                  | Euphorbiaceae     | Leaves              | IZD = 10.0 ± 0.5 mm (240 µg/disc) | [59] |
| *Kaempferia galanga* Hook.                  | Zingiberaceae     | Stem                | IZD = 9.6 ± 0.6 mm (240 µg/disc) | [59] |
| *Garcinia indica* Wight (cited as *Mitrasacme alsinoides*) | Loganiaceae       | Leaves              | IZD = 10.7 ± 2.0 mm (240 µg/disc) | [59] |
| *Orthosiphon aristatus* (Blume) Miq. (cited as *Orthosiphon stamineus*) | Lamiaceae         | Whole plant         | IZD = 10.7 ± 2.0 mm (240 µg/disc) | [59] |
| *Paonia × suffruticosa* Andrews             | Paeoniaceae       | Root Cortex         | IZD = 23.9–26.7 mm (1–10 mg/disc) | [82] |
| *Parkia speciosa* Hassk.                    | Leguminosae       | Leaves              | IZD = 19.3 ± 2.2 mm (240 µg/disc) | [59] |
| *Phaeomeria imperialis* (Roscoe) Lindl.     | Zingiberaceae     | Flowers             | IZD = 14.0 ± 0.6 mm (240 µg/disc) | [59] |
| *Phyllanthus niruri* L.                     | Phyllanthaceae    | Whole plant         | IZD = 9.8 ± 0.8 mm (240 µg/disc) | [59] |
| *Piper betle* L.                            | Piperaceae        | Leaves              | IZD = 25.8 ± 0.8 mm (240 µg/disc) | [59] |
| *Piper betle* L.                            | Piperaceae        | Leaves              | IZD = 11.0 ± 0.6 mm (240 µg/disc) | [59] |
| *Persicaria minor* (Huds.) Opiz (cited as *Polygonum minus*) | Polygonaceae      | Leaves              | IZD = 12.3 ± 0.8 mm (240 µg/disc) | [59] |
| *Psidium guajava* L.                        | Myrtaceae         | Leaves              | IZD = 10.0 ± 0.6 mm (240 µg/disc) | [59] |
| *Sambucus ebulus*                          | Adoxaceae         | Aerial parts        | MIC = 31.2 µg/mL        | [54] |
| *Sesbania grandiflora* (L.) Pers.           | Leguminosae       | Leaves              | IZD = 8.8 ± 1.1 mm (240 µg/disc) | [59] |
| *Solanum tourneui Sw.                       | Solanaceae        | Seed                | IZD = 8.7 ± 0.0 mm (240 µg/disc) | [59] |
| *Tinospora sinensis* (Lour.) Merr. (cited as *Tinospora cordifolia*) | Menispermaceae    | Stem                | IZD = 19.2 ± 5 mm (240 µg/disc) | [59] |
| *Zingiber officinale* Roscoe                | Zingiberaceae     | Rhizome             | IZD = 41.5 ± 7.0 mm (240 µg/disc) | [59] |

MIC, minimal inhibitory concentration; MIC_{50} and MIC_{90}, minimal inhibitory concentration required to inhibit 50% and 90% of cells growth, respectively; IZD, inhibition zone diameter.
Table 7. Plant petroleum ether extracts with anti-\(H. pylori\) activity.

| Species                                   | Family             | Parts        | Anti-\(H. pylori\) Potency | Ref. | 
|-------------------------------------------|--------------------|--------------|----------------------------|------| 
| *Calotropis gigantea* (L.) W.T. Aiton     | Apocynaceae        | Leaves       | IZD = 13.2 ± 0.8 mm (240 µg/disc) | [59] | 
| *Centella asiatica* (L.) Urb.             | Apiaceae           | Whole plant  | IZD = 8.5 ± 0.6 mm (240 µg/disc) | [59] | 
| *Chromolaena odorata* (L.) R.M. King and H. Rob. | Asteraceae        | Leaves       | IZD = 20.3 ± 1.4 mm (240 µg/disc) | [59] | 
| *Colubrina asiatica* (L.) Brongn.         | Rhamnaceae         | Leaves       | IZD = 11.0 ± 0.9 mm (240 µg/disc) | [59] | 
| *Cosmos caudatus* Kunth                   | Asteraceae         | Leaves       | IZD = 16.0 ± 0.6 mm (240 µg/disc) | [59] | 
| *Cymbopogon citratus* (DC.) Stapf         | Poaceae            | Stem         | IZD = 29.5 ± 1.5 mm (240 µg/disc) | [59] | 
| *Derris trifoliata* Lour.                 | Leguminosae        | Stem         | IZD = 42.0 ± 0.9 mm (240 µg/disc); MIC\(_{50}\) = 1 mg/mL; MIC\(_{90}\) = 2 mg/L | [59] | 
| *Desmostachya bipinnata* (L.) Stapf.      | Gramineae          | Whole plant  | IZD = 42.0 ± 1.0 mm (240 µg/disc) | [59] | 
| *Ficus deltoidea* Jack                    | Moraceae           | Leaves       | IZD = 8.0 ± 0.1 mm (240 µg/disc) | [59] | 
| *Heterotheca inuloides* Cass.             | Compositae         | Stem         | IZD = 13.2 ± 0.1 mm (240 µg/disc) | [59] | 
| *Jatropha podagrica* Hook.                | Euphorbiaceae      | Root         | IZD = 47.3 ± 3.1 mm (240 µg/disc) | [59] | 
| *Kaempferia galanga* L.                   | Zingiberaceae      | Tuber        | IZD = 18.3 ± 1.0 mm (240 µg/disc) | [59] | 
| *Alpinia galanga* (L.) Willd. (cited as Languas galanga) | Zingiberaceae      | Tuber        | IZD = 39.3 ± 2.1 mm (240 µg/disc) | [59] | 
| *Limnocharis flava* (L.) Buchenau         | Alismataceae       | Leaves       | IZD = 24.0 ± 0.6 mm (240 µg/disc) | [59] | 
| *Melastoma malabathricum* L. (blue variety) | Melastomataceae   | Stem         | IZD = 10.5 ± 0.8 mm (240 µg/disc) | [59] | 
| *Mimosa pudica* L.                        | Leguminosae        | Whole plant  | IZD = 8.5 ± 0.6 mm (240 µg/disc) | [59] | 
| *Mitrasacme indica* Wight (cited as Mitrasacme alsinoidea R. Br.) | Loganiaceae        | Leaves       | IZD = 11.0 ± 0.6 mm (240 µg/disc) | [59] | 
| *Neptunia oleracea* Lour.                 | Leguminosae        | Leaves       | IZD = 10.5 ± 0.8 mm (240 µg/disc) | [59] | 
| *Orthosiphon aristatus* (Blume) Miq. (cited as Orthosiphon stamineus) | Lamiaceae          | Stems        | IZD = 12.7 ± 0.5 mm (240 µg/disc) | [59] | 
| *Parkia speciosa* Hassk.                  | Leguminosae        | Seeds        | IZD = 10.5 ± 0.8 mm (240 µg/disc) | [59] | 
| *Pereskia scharosara* Griseb.             | Cactaceae          | Leaves       | IZD = 13.3 ± 0.5 mm (240 µg/disc) | [59] | 
| *Etlingera elatior* (Jack) R.M.Sm. (cited as Phloeomeria imperialis) | Zingiberaceae      | Flowers      | IZD = 18.0 ± 1.1 mm (240 µg/disc) | [59] | 
| *Phyllanthus niruri* L.                   | Phyllanthaceae     | Whole plant  | IZD = 14.0 ± 1.6 mm (240 µg/disc) | [59] | 
| *Piper betle* L.                          | Piperaceae         | Leaves       | IZD = 54.2 ± 0.8 mm (240 µg/disc) | [59] |
Table 7. Cont.

| Species Family | Parts | Anti-\(H.\) pylori Potency |
|----------------|-------|---------------------------|
| Pluchea indica (L.) Less. | Compositae Leaves | \(IZD = 13.7 \pm 1.9 \text{ mm} (240 \mu\text{g/disc})\) [59] |
| Persicaria minor (Huds.) Opiz (cited as Polygonum minus) | Polygonaceae Leaves | \(IZD = 15.5 \pm 0.6 \text{ mm} (240 \mu\text{g/disc})\) [59] |
| Psidium guajava L. | Myrtaceae Leaves | \(IZD = 8.5 \pm 0.8 \text{ mm} (240 \mu\text{g/disc})\) [59] |
| Sesbania grandiflora (L.) Pers. | Leguminosae Leaves | \(IZD = 10.8 \pm 1.0 \text{ mm} (240 \mu\text{g/disc})\) [59] |
| Solanum torvum Sw. | Solanaceae Seeds | \(IZD = 11.0 \pm 0.9 \text{ mm} (240 \mu\text{g/disc})\) [59] |
| Tinospora sinensis (Lour.) Merr. (cited as Tinospora cordifolia) | Menispermaceae Stems | \(IZD = 10.7 \pm 0.8 \text{ mm} (240 \mu\text{g/disc})\) [59] |
| Zingiber officinalis Roscoe | Zingiberaceae Rhizome | \(IZD = 33.3 \pm 1.6 \text{ mm} (240 \mu\text{g/disc})\) [59] |

MIC, minimal inhibitory concentration; MIC\(_{50}\), minimal inhibitory concentration required to inhibit 50% of cells growth; IZD, inhibition zone diameter.

Table 8. Plant methanol/water, ethanol/water, methanol/petroleum, and methanol/dichloromethane extracts with anti-\(H.\) pylori activity.

| Species | Family | Parts | Anti-\(H.\) pylori Potency |
|---------|-------|-------|---------------------------|
| Acacia seyal Delile | Leguminosae Stem | MIC = 20 mg/mL [84] |
| Allagi maurorum Medik. | Leguminosae Leaves | MIC = 20 mg/mL [84] |
| Bidens bipinnata L. | Compositae Whole plant | MIC = 0.79 mg/mL [84] |
| Capparis spinose L. | Capparaceae Aerial parts | MIC = 25 mg/mL [84] |
| Casimiroa edulis Llave and Lex | Rutaceae Unripe fruit | MIC = 20 mg/mL [84] |
| Centaurea alexandrina Delile | Compositae Whole plant | MIC = 80 mg/mL [84] |
| Centaurea pelia DC. | Compositae ND | MIC = 0.625–5 mg/mL [85] |
| Centaurea thessala Hausskn. ssp. drakensis (Freyn and Sint.) Georg | Compositae ND | MIC = 0.625–5 mg/mL [85] |
| Cerastium candidissimum L. | Carophyllaceae ND | MIC = 0.625–2.5 mg/mL [85] |
| Chamaemilla recutita (L.) Rauschert | Compositae ND | MIC = 0.625–2.5 mg/mL [85] |
| Cleome africana Botsch. | Cleomaceae Whole plant | MIC = 0.158 mg/mL [84] |
| Conyza albida Willd. ex Spreng. | Asteraceae ND | MIC = 0.625–2.5 mg/mL [85] |
| Conyza bonariensis (L.) Cronquist. | Asteraceae ND | MIC = 0.625–2.5 mg/mL [85] |
| Cota palatistina Reut. ex Unger and Kotschy (cited as Anthemis melanolepis) | Compositae ND | MIC = 0.625–2.5 mg/mL [85] |
| Desmostachya bipinnata (L.) Stapf. | Gramineae Whole plant | MIC = 0.040 mg/mL [84] |
| Dittrichia viscosa (L.) Greuter subsp. revoluta | Asteraceae ND | MIC = 0.625–2.5 mg/mL [85] |
| Euphorbia retusa Forssk. | Euphorbiaceae Root | MIC = 2.5 mg/mL [84] |
| Glossostemon brugueirii Desf. | Sterculiaceae Leaves | MIC = 25 mg/mL [84] |
Table 8. Cont.

| Species                                  | Family           | Parts           | Anti-\textit{H. pylori} Potency       | Ref.   |
|------------------------------------------|------------------|-----------------|---------------------------------------|--------|
| \textit{Hamada elegans} (Bunge) Botsch.  | Chenopodiaceae   | Whole plant     | MIC = 10 mg/mL                         | [84]   |
| \textit{Haplophyllum tuberculatum} (Forsk.) A. Juss. | Rutaceae         | Whole plant     | MIC = 1.58 mg/mL                       | [84]   |
| Lythrum salicaria L.*                    | Lythraceae       | Aerial parts    | IZD = 17 \pm 0.08 mm (500 mg/mL)      | [86]   |
| \textit{Marrubium vulgare} L.            | Lamiaceae        | Whole plant     | MIC = 0.251 mg/mL                      | [84]   |
| \textit{Ocinum basilicum} L.             | Lamiaceae        | Aerial parts    | MIC = 0.625–5 mg/mL                    | [85]   |
| \textit{Origanum dictamnus} L.           | Lamiaceae        | Whole plant     | MIC = 0.625–5 mg/mL                    | [85]   |
| \textit{Origanum majorana} L.            | Lamiaceae        | Aerial parts    | MIC = 0.625–5 mg/mL                    | [85]   |
| \textit{Origanum vulgare} L.             | Lamiaceae        | Leaves          | MIC = 0.625–2.5 mg/mL                  | [85]   |
| \textit{Schausia thebaica} Webb.         | Brassicaceae     | Whole plant     | MIC = 25 mg/mL                         | [84]   |
| \textit{Sisymbrium irio} L.              | Lamiaceae        | Whole plant     | MIC = 0.074 mg/mL                      | [84]   |
| \textit{Stachys alopecuros} (L.) Benth.  | Lamiaceae        | Aerial parts    | MIC = 0.625–2.5 mg/mL                  | [85]   |
| \textit{Thymbra capitata} (L.) Cav. (cited as \textit{Thymus capitatus}) | Lamiaceae        | Whole plant     | MIC = 12.5 mg/mL                       | [84]   |
| \textit{Trifolium alexandrinum} L.       | Leguminosae      | Whole plant     | MIC = 25 mg/mL                         | [84]   |

\textbf{Ethanol/Water (70:30, v/v)}

| Species                                  | Family           | Parts           | Anti-\textit{H. pylori} Potency       | Ref.   |
|------------------------------------------|------------------|-----------------|---------------------------------------|--------|
| \textit{Calophyllum brasiliense} Cambess. | Clusiaceae       | Bark            | MIC = 31 µg/mL; IZD = 8–14 mm (62.5–1000 µg/disc) | [75]   |
| \textit{Cocculus hirsutus} (L.) Diels.   | Menispermaceae   | Leaves          | IZD = 26 mm (200–1000 µg/mL)          | [56]   |
| \textit{Fridericia chica} (Bonpl.) L. G. Lohmann (cited as \textit{Arrabidaea chica}) | Bignoniaceae     | Fresh leaves    | 12.5                                   | [87]   |
| \textit{Hancornia speciosa} Comuzo       | Apocynaceae      | Bark            | MIC = 125 µg/mL                       | [88]   |

\textbf{Methanol/Petroleum (1:1)}

| Species                                  | Family           | Parts           | Anti-\textit{H. pylori} Potency       | Ref.   |
|------------------------------------------|------------------|-----------------|---------------------------------------|--------|
| \textit{Carum bulbocastanum} (L.) Koch.  | Apiaceae         | Fruit           | MIC = 31.25–250 µg/mL                 | [46]   |
| \textit{Carum carvi} L.                  | Apiaceae         | Fruit           | MIC = 31.25–125 µg/mL                 | [46]   |
| \textit{Glycyrrhiza glabra} Linn         | Leguminosae      | Root            | MIC = 15.6–250 µg/mL                  | [46]   |
| \textit{Mentha longifolia} (L.) Huds.    | Lamiaceae        | Aerial parts    | MIC = 31.25–125 µg/mL                 | [46]   |
| \textit{Salvia limbata} C. A. Mey.       | Lamiaceae        | Aerial parts    | MIC = 125–250 µg/mL                   | [46]   |
| Salvia sclarea L.                        | Lamiaceae        | Aerial parts    | MIC = 125–500 µg/mL                   | [46]   |
| \textit{Trachyspermum amni} (L.) Sprague (cited as \textit{Trachyspermum copticum}) | Apiaceae        | Aerial parts    | MIC = 31.25–250 µg/mL                 | [46,89]|
| \textit{Xanthium strumarium} subsp. \textit{brasilicum} (Vell.) O. Bolos and Vigo (cited as \textit{Xanthium brasiliicum}) | Compositae      | Aerial parts    | MIC = 31.25–250 µg/mL                 | [46,89]|
| \textit{Ziziphora clinopodioides} Lam.   | Lamiaceae        | Aerial parts    | MIC = 31.25–125 µg/mL                 | [46]   |

\textbf{Methanol/Dichloromethan}

| Species                                  | Family           | Parts           | Anti-\textit{H. pylori} Potency       | Ref.   |
|------------------------------------------|------------------|-----------------|---------------------------------------|--------|
| \textit{Cyrtocarpa procera} Kunth        | Anacardiaceae    | Bark            | MIC = 62.5 µg/mL                      | [58]   |

* Methanol/water (80:20, v/v); ND, not defined; MIC, minimal inhibitory concentration; IZD, inhibition zone diameter.
Table 9. Plant cyclohexane, dichloromethane, ethyl acetate, n-Butanol, n-Hexane, and other extracts with anti-*H. pylori* activity.

| Species                          | Family     | Parts            | Anti-*H. pylori* Potency | Ref. |
|----------------------------------|------------|------------------|--------------------------|------|
| **Cyclohexane**                  |            |                  |                          |      |
| *Alchemilla fissa* Günther and Schummel | Rosaceae   | Aerial parts     | MIC = 64–256 µg/mL       | [71] |
| *Alchemilla glabra* Neygenf.      | Rosaceae   | Aerial parts     | MIC = 64–256 µg/mL       | [71] |
| *Alchemilla monticola* Opiz       | Rosaceae   | Aerial parts     | MIC = 16–64 µg/mL        | [71] |
| *Alchemilla viridiflora* Rothm.   | Rosaceae   | Aerial parts     | MIC = 64–256 µg/mL       | [71] |
| *Alchemilla fissa* Günther and Schummel | Rosaceae   | Aerial parts     | MIC = 16–128 µg/mL       | [71] |
| *Calophyllum brasiliense* Cambess. | Clusiaceae | Bark             | IZD = 7–10 mm (62.5–1000 µg/disc) | [75] |
| *Cyrtocarpa procera* Kunth        | Anacardiaceae | Bark            | MIC = 15.6 µg/mL         | [58] |
| **Dichloromethane**              |            |                  |                          |      |
| *Alchemilla fissa* Günther and Schummel | Rosaceae   | Aerial parts     | MIC = 64–256 µg/mL       | [71] |
| *Alchemilla glabra* Neygenf.      | Rosaceae   | Aerial parts     | MIC = 64–256 µg/mL       | [71] |
| *Alchemilla monticola* Opiz       | Rosaceae   | Aerial parts     | MIC = 16–64 µg/mL        | [71] |
| *Alchemilla viridiflora* Rothm.   | Rosaceae   | Aerial parts     | MIC = 64–256 µg/mL       | [71] |
| *Calophyllum brasiliense* Cambess. | Clusiaceae | Bark             | MIC = 125 µg/mL          | [71] |
| *Cyrtocarpa procera* Kunth        | Anacardiaceae | Bark            | IZD = 7–10 mm (62.5–1000 µg/disc) | [75] |
| **Ethyl acetate**                |            |                  |                          |      |
| *Alepidea Amatyynbica* Eckl. and Zeyh | Apiaceae   | Roots/rhizomes   | IZD = 8.5 ± 4.8 mm       | [50,51] |
| *Bidens pilosa* L.                | Compositae | Leaves           | MIC = 128–512 µg/mL      | [75] |
| *Bridelia micrantha* (Hochst.) Baill. | Phyllanthaceae | Bark         | IZD = 12–20 mm;          | [53] |
| *Combretum molle* R. Br. Ex G. Don | Combretaceae | Bark            | MIC = 0.79 mg/mL         | [50,51] |
| *Desmostachya bipinnata* (L.) Stapf. | Graminaceae | Whole plant     | MIC = 128–512 µg/mL      | [75] |
| *Eryngium foetidium* (Linn)       | Apiaceae   | Leaves           | IZD = 5.1 ± 4.6 mm       | [50,51] |
| *Garcinia kola* Heckel             | Guttiferae | Seeds            | MIC = 128–512 µg/mL      | [75] |
| *Galinsoga ciliata* (Raf.) S. F. Blake | Compositae | Leaves           | MIC = 128–512 µg/mL      | [75] |
| *Geranium wilfordii* Maxim        | Geraniaceae | Aerial parts     | MIC = 30 µg/mL           | [90] |
| *Paeonia × suffruticosa* Andrews   | Paeoniaceae | Root Cortex    | IZD = 14.1–19.9 mm (1–10 mg/disc) | [82] |
| *Physalis alkekengi* L. var. franchetii* (Mast.) Makino | Solanaceae | Aerial parts     | MIC = 500 µg/mL          | [91] |
| *Sclerocarya birrea* A. Rich Hochst | Anacardiaceae | Stem bark      | IZD = 13.2 ± 2.8 mm      | [50,51] |
Table 9. Cont.

| Species                          | Family         | Parts         | Anti-\textit{H. pylori} Potency | Ref.  |
|----------------------------------|----------------|---------------|---------------------------------|-------|
| \textit{Centaurea solstitialis}  | \textit{Asteraceae} | Aerial parts  | MIC = 31.2 µg/mL                | [54]  |
| subsp. \textit{solstitialis}     |                |               |                                 |       |
| \textit{Cistus laurifolius}      | \textit{Cistaceae} | Flowers       | MIC = 62.5–125 µg/mL            | [54]  |
| \textit{Hypericum perforatum}   | \textit{Hypericaceae} | Aerial parts  | MIC = 15.6–31.2 µg/mL          | [54]  |
| \textit{Momordica charantia}    | \textit{Cucurbitaceae} | Fruits       | MIC = 62.5 µg/mL                | [54]  |

\textit{n-Butanol}

| Calophyllum brasiliense Cambess. | \textit{Clusiaceae} | Bark          | IZD = 7–14 mm (100–400 µg/disc) | [92]  |
|                                 |                  |               | IZD = 7–8 mm (62.5–1000 µg/disc) | [75]  |
|                                 |                  |               | IZD = 14 mm (400 mg/mL)         | [75]  |
|                                 |                  |               | MIC = 31 µg/mL                  |       |
| \textit{Cyrtocarpa proceria}    | \textit{Anacardiaceae} | Bark         | MIC = 7.81 µg/mL                | [58]  |
| Kunth                           |                  |               |                                 |       |
| \textit{Eucalyptus camaldulensis} | \textit{Myrtaceae} | Stem bark     | MIC = 25–200 µg/mL              | [76]  |
| Dehnh                           |                  | Leaves        | MIC = 50 µg/mL                  | [76]  |
| \textit{Eucalyptus torelliana}  | \textit{Myrtaceae} | Leaves        | MIC = 25–50 µg/mL               | [76]  |
| F. Muell.                       |                  | Stem bark     | MIC = 25–200 µg/mL              | [76]  |
| Mitrella kentii (Bl.) Miq       | \textit{Annonaceae} | Bark          | MIC = 125 µg/mL                 | [93]  |
| \textit{Paeonia \times}         | \textit{Paeoniacae} | Root Cortex   | IZD = 29.9–31.3 mm (1–10 mg/disc) | [82]  |
| suffruticosa Andrews            |                  |               |                                 |       |

\textit{n-Hexane}

\textit{Others}

| \textit{Camellia sinensis} (L.) Kuntze | \textit{Theaceae} | Young shoots  | IZD = 22.5 mm (20–60 µg/disc) | [94]  |
|                                      |                  |               | MBC = 4 mg/mL                 |       |
| \textit{Chenopodium ambrosioides} L. | \textit{Amaranthaceae} | Aerial parts | IZD = 18 mm (20–60 µg/disc)   | [94]  |
|                                      |                  |               | MBC = 5.5 mg/mL               |       |
|                                      |                  |               | MIC = 16 mg/L *                | [95]  |

\* 1 and 2 × MIC completely inhibited \textit{H. pylori} growth at 24 h; MIC, minimal inhibitory concentration; \textit{MIC}_{50}, minimal inhibitory concentration required to inhibit 50% of cells growth; MBC, minimal bactericidal concentration; IZD, inhibition zone diameter.
Table 10. Bioactive compounds with anti-\textit{H. pylori} activity.

| Plant Species                    | Bioactive Compounds                  | Anti-\textit{H. pylori} Potency (MIC) | Ref. |
|----------------------------------|--------------------------------------|--------------------------------------|------|
| \textit{Allium sativum} L. (cloves) | Allicin (garlic poder) 4 µg/mL [96] |                                      |      |
|                                  | Allicin 6 µg/mL [96]                  |                                      |      |
|                                  | Diallyl disulfide 100–200 µg/mL [96] |                                      |      |
|                                  | Diallyl tetrasulfide 3–6 µg/mL [96]  |                                      |      |
| \textit{Convolvulus austro-aegyptiacu} Abdallah and Saad (aerial parts) | Scopoletin 50–200 µg/mL [67]       |                                      |      |
|                                  | Scopolin 50–100 µg/mL [67]           |                                      |      |
| \textit{Glycyrrhiza glabra} L. (roots) | Licoricidin 6.25–12.5 µg/mL [78]    |                                      |      |
|                                  | Licoisoflavone 6.25 µg/mL [78]       |                                      |      |
|                                  | Fuscaxanthone I 15.2–122.0 µM [97]   |                                      |      |
|                                  | Beta-Mangostin 18.3–147.3 µM [97]    |                                      |      |
|                                  | Fuscaxanthone A 16.3–131.2 µM [97]   |                                      |      |
|                                  | Cowanin 16.3–130.6 µM [97]           |                                      |      |
|                                  | Cowaxanthone 4.6–152.3 µg/mL [97]    |                                      |      |
|                                  | Alpha-Mangostin 19.0–76.1 µM [97]    |                                      |      |
|                                  | Cowanol 15.7–126.4 µM [97]           |                                      |      |
|                                  | Isojacareubin 23.9 µM [97]           |                                      |      |
|                                  | Fuscaxanthone G 16.3–130.6 µM [97]   |                                      |      |
|                                  | Nigrolineabiphenyl B 56.5–226.3 µM [97] |                                  |      |
|                                  | 1,3,5,6-Tetrahydroxyxanthone 29.9–240.3 µM [97] | |      |
|                                  | Vokensiflavone 14.4–115.7 µg/mL [97] |                                      |      |
|                                  | Morelloflavone 14.0–112.3 µM [97]    |                                      |      |
| \textit{Hydrastis canadensis} L. (rhizomes) | Berberine 0.78–25 µg/mL [80]    |                                      |      |
|                                  | β-Hydrastine 25–100 µg/mL [80]       |                                      |      |
| \textit{Sanguinaria canadensis} L. (rhizomes) | Sanguinarine 6.25–50 µg/mL [80]    |                                      |      |
|                                  | Chelerythrine 25–100 µg/mL [80]      |                                      |      |
|                                  | Protopine 25 ≥ 100 µg/mL [80]        |                                      |      |
| \textit{Tinospora sagittata} Gagnep. (aerial parts) | Palmatine 3.12–6.25 µg/mL [42] |                                      |      |

MIC, minimal inhibitory concentration.
5. In Vivo Findings

_H. pylori_ colonization is increasingly being associated with a heightened risk of developing upper gastrointestinal tract diseases. Despite many plant extracts having demonstrated a prominent _H. pylori_ inhibition capacity in culture, it is of crucial importance to assess their in vivo efficacy, because it is pivotal to ascertain their effective antibacterial potency. However, a relatively low number of medicinal plants have been investigated to date for in vivo activity, as discussed below.

_Paeonia lactiflora_ root extract (100 µg/mL) showed a complete inhibition of _H. pylori_ colonization (4–5 × 10⁵ colony forming unit (CFU)), being the antibacterial potential equivalent to of ampicillin used as positive control (10 µg/mL) (2–4 × 10⁵ CFU) [98]. Time course viability experiments were also performed in simulated gastric environments to assess the anti-_H. pylori_ activity of garlic (_Allium sativum_) oil (16 and 32 µg/mL). A rapid anti-_H. pylori_ action in artificial gastric juice was found. Nevertheless, the anti-_H. pylori_ activity displayed by garlic oil was noticeably affected by food materials and mucin, despite the fact that a substantial activity remained under simulated gastric conditions [65]. Also, _H. pylori_-inoculated Swiss mice receiving 125, 250, or 500 mg/kg of _Bryophyllum pinnatum_ or ciprofloxacin (500 mg/kg) for 7 days, showed a significant reduction of _H. pylori_ colonization on gastric tissue from 100% to 17%. In addition, the highest _B. pinnatum_ extract tested (85.91 ± 52.91 CFU) and standard drug ciprofloxacin (25.74 ± 16.15 CFU) also reduced significantly (_p_ < 0.05) the bacterial load of gastric mucosa as compared with untreated infected mice (11883 ± 1831 CFU) [74]. On the other hand, _Eryngium foetidum_ methanol extract (381.9 ± 239.5 CFU) and positive control ciprofloxacin (248 ± 153.2 CFU) significantly reduced the bacterial load in gastric mucosa at the same dose (500 mg/kg) compared with untreated and inoculated mice (14350 ± 690 CFU) [73].

_Hippocratea celastroides_ hydroethanolic root-bark extract, a widely used plant against gastric and intestinal infections, also showed anti-_H. pylori_ efficacy in naturally infected dogs. In a study of 18 experimental dogs treated with a dose of 93.5–500 mg/kg of _H. celastroides_ extract in weight and 19 infected dogs receiving amoxicillin–clarithromycin–omeprazole (control treatment), the results showed effectiveness of 33.3 and 55% in the experimental and control groups, respectively [99]. On the other hand, Ye et al. [95], aiming to investigate the in vivo bactericidal effects of _Chenopodium ambrosioides_ L. against _H. pylori_, randomly assigned _H. pylori_-infected mice into plant extract group, triple therapy control (lansoprazole, metronidazole, and clarithromycin), blank control, and _H. pylori_ control groups. The obtained eradication ratios, determined by rapid urease tests (RUTs) and histopathology, were, respectively, 60% (6/10) using RUT and 50% (5/10) using histopathology for the test group and both 70% (7/10) for the control group. In addition, the histopathologic evaluation revealed a massive bacterial colonization on the gastric mucosa surface and slight mononuclear cells infiltration after _H. pylori_ inoculation, but no obvious inflammation or other pathologic changes in gastric mucosa were stated between the _C. ambrosioides_-treated mice and the standard therapy.

_Tinospora sagittata_ and its main component, palmatine, showed in vitro bactericidal effects on _H pylori_ strains, with both MIC and minimal bactericidal concentration (MBC) values of 6250 µg/mL, whereas palmatine’s MIC value against _H. pylori_ SCYA201401 was 6.25 µg/mL and against _H. pylori_ SS1 was 3.12 µg/mL. The time-kill kinetic study evidenced a dose-dependent and progressive decline in the numbers of viable bacteria up to 40 h. _H. pylori_-infected mice treated with extract, palmatine, or control therapy (omeprazole, clarithromycin, and amoxicillin), presented eradication ratios of, respectively, 80%, 50%, and 70%. The anti-_H. pylori_ activity found in _T. sagittata_ extracts and its major constituent, palmatine, both in culture and animal models, clearly highlights the antibacterial potential of this plant in the treatment of both infected humans and animals [42].
Total alkaloids fraction activity (TASA) of *Sophora alopecuroides* L., widely used in herbal remedies against stomach-associated diseases, were also investigated on 120 *H. pylori*-infected BALB/c mice mouse gastritis. A total of 100 infected mice were randomly assigned into 10 treatment groups: group I (normal saline); group II (bismuth pectin); group III (omeprazole); group IV (TASA 2 mg/day); group V (TASA 4 mg/day); group VI (TASA 5 mg/day); group VII (TASA + bismuth pectin); group VIII (TASA + omeprazole); group IX (bismuth pectin + clarithromycin + metronidazole); and group X (omeprazole + clarithromycin + metronidazole). The mice were sacrificed 4 weeks after treatment. Real-time PCR was used to detect 16sDNA of *H. pylori* to test both the colonization and mice clearance of bacteria of each treatment. Hematoxylin and eosin staining and immunostaining of mice gastric mucosa were also used to observe the general inflammation and related factors: IL-8, COX2, and nuclear factor-kappa B (NF-κB) expression changed after treatments. TASA combined with omeprazole or bismuth pectin showed promising antimicrobial activity against *H. pylori*, as well as conventional triple therapy. Indeed, hematoxylin and eosin staining and immune-staining of mice gastric mucosa evidenced that the inflammation on mice gastric mucosal membrane were also clearly relieved in TASA combined treatments and conventional triple therapy compared with normal saline-treated mice. Accordingly, from immunohistochemistry results, *H. pylori*-induced IL-8, COX2, and NF-κB were consistently suppressed in the seventh, eighth, ninth, and tenth groups to a certain extent \[100\].

Pastene et al. \[101\] investigated the inhibitory effects of a standardized apple peel polyphenol-rich extract (*Malus pumila* Mill., cited as *Malus domestica*) against *H. pylori* infection and vacuolating bacterial toxin (VacA)-induced vacuolation and found that the preparation significantly prevented vacuolation in HeLa cells with an IC$_{50}$ value of 390 µg gallic acid equivalents (GAE)/mL and an in vitro anti-adhesive effect against *H. pylori*. A significant inhibition was also stated with 20–60% reduction of *H. pylori* attachment at concentrations between 0.250 and 5 mg GAE/mL. In a short-term infection model (C57BL6/J mice), doses of 150 and 300 mg/kg/day showed an inhibitory effect on *H. pylori* attachment. Orally administered apple peel polyphenols also showed an anti-inflammatory effect on *H. pylori*-associated gastritis, lowering malondialdehyde levels and gastritis scores.

Kim et al. \[102\] investigated the GutGard™ ability (a flavonoid rich, *Glycyrrhiza glabra* root extract) to inhibit *H. pylori* growth both in Mongolian gerbils and C57BL/6 mouse models. Infected male Mongolian gerbils were orally treated once daily 6 times/week for 8 weeks with 15, 30, and 60 mg/kg GutGard™. Bacterial identification in the biopsy samples of gastric mucosa, via urease, catalase, and ELISA, as well as immunohistochemistry revealed a dose-dependent inhibition of *H. pylori* colonization in gastric mucosa by GutGard™. As well, the administration of 25 mg/kg GutGard™ in *H. pylori*-infected C57BL/6 mice significantly reduced *H. pylori* colonization in gastric mucosa, suggesting its usefulness in *H. pylori* infection prevention.

*Calophyllum brasiliense* stem bark preparations are popular remedies for the treatment of chronic ulcers. A current report evidenced gastroprotective, gastric acid inhibitory properties and anti-*H. pylori* activity in culture (MIC = 31 µg/mL) \[75\]. Hydroethanolic (50, 100, and 200 mg/kg) and dichloromethane (100 and 200 mg/kg) fractions-treated Wistar rats ulcerated by acetic acid and inoculated with *H. pylori* showed a marked delay in ulcer healing and reduced the ulcerated area in a dose-dependent manner \[75\]. While the dichloromethane fraction, at 200 mg/kg, increased PGE2 levels, both the hydroethanolic and dichloromethane fractions decreased the number of urease-positive animals, as confirmed by the reduction of the *H. pylori* presence in histopathological analysis. This aspect suggests that the antulcer activity of *C. brasiliense* is partly linked with its anti-*H. pylori* efficacy \[75\]. Also, phenolic-rich oregano (*Origanum vulgare*) and cranberry (*Vaccinium macrocarpon*) extracts showed a prominent ability to inhibit *H. pylori* through urease inhibition and disruption of energy production by inhibition of proline dehydrogenase at the plasma membrane \[103\].
6. Urease Inhibition

The current therapies are challenged by the considerable number of emerging *H. pylori*-resistant strains. This fact has driven the need for alternative anti-*H. pylori* therapies that ideally should have good stability and low toxicity and to be able to inhibit urease activity [62]. It has been shown that *H. pylori* urease activity is crucial in bacterial survival and pathogenesis [104].

The inhibitory potency of some anti-*H. pylori* medicinal plants has been reported [62] and even investigated by some authors in the involved mechanisms of antibacterial action of those plant products [63].

Table 11 briefly shows the studied plant extracts with prominent anti-urease activity. Amin et al. [49] demonstrated that the methanolic and acetone extracts of some medicinal plants were able to inhibit urease activity. In fact, *Acacia nilotica* flower methanol and acetone extracts evidenced anti-*H. pylori* activity, being MIC values of 8–64 µg/mL and 4–64 µg/mL, respectively. Both extracts inhibited urease activity at 8.2–88.2% and 9.2–86.6%. *Calotropis procera* leaf and flower methanol and acetone extracts, with MIC values of 16–256 µg/mL, 32–256 µg/mL, and 8–128 µg/mL also displayed urease inhibitory effects, being, respectively, 12.2–48.2% and 7.2–58.2% for leaf and 9.3–68.2% for flower acetone extracts [49]. While *A. nilotica* extract exerted a competitive inhibition, that of *C. procera* extract displayed a mixed type of inhibition [49]. In addition, *Casuarina equisetifolia* fruit methanol extract, with MIC values varying from 128–512 µg/mL, also displayed 12.2–86.2% inhibition of urease activity [49].

In another study, *Camellia sinensis* young non-fermented and semi-fermented shoot extracts, presented inhibition zone diameter (IZD) and MBC of, respectively, 22.5 mm at 20–60 µg/disk and 4 mg/mL, and 18 mm at 20–60 µg/disk and 5.5 mg/mL. They both inhibited Ure A and Ure B subunits production at 2.5 and 3.5 mg/mL [94]. Also, the *Chamomilla recutita* flower extract, which inhibited *H. pylori* growth at an MIC90 value of 125 mg/mL and a MIC50 value of 62.5 mg/mL, was able to inhibit the urease production [105]. In the same line, the methanol fraction of *Euphorbia umbellata* bark extract inhibited both *H. pylori* growth (44.6% inhibition) at 256 µg/mL and urease activity (78.6% inhibition) at 1024 µg/mL [77]. Moreover, the *Peumus boldus* flower aqueous extract showed anti-adherent activity against *H. pylori* and inhibited urease activity with an IC50 value of 23.4 µg GAE/mL [61]. The aqueous extract of *Terminalia chebula* fruit showed activity with MIC and MBC values of 125 mg/mL and 150 mg/mL, respectively, and inhibited *H. pylori* urease activity at a concentration of 1–2.5 mg/mL [63].
Table 11. Urease inhibitory potential of plant extracts.

| Plant Species                      | Parts             | Extraction Solvent          | Concentration Tested | Urease Inhibition   | Ref. |
|------------------------------------|-------------------|-----------------------------|----------------------|---------------------|------|
| *Acacia nilotica* (L.) Delile      | Leaves            | Methanol                    | 8–128 µg/mL          | 8.21–88.21%         | [49] |
|                                    | Flowers           | Acetone                     | 8–128 µg/mL          | 9.20–86.56%         | [49] |
| *Calotropis procera* (Aiton) W.T. Aiton | Leaves          | Methanol                    | 16–256 µg/mL         | 12.23–48.22%        | [49] |
|                                    | Flowers           | Acetone                     | 32–256 µg/mL         | 7.23–58.21%         | [49] |
| *Camellia sinensis* (L.) Kuntze    | Young shoots      | Methanol: water (62.5:37.5 v/v) | 2.5 mg/mL            | 100% Ure A and B   | [94] |
|                                    |                   | Methanol: water (62.5:37.5 v/v) | 3.5 mg/mL            | 100% Ure A and B   | [94] |
| *Casuarina equisetifolia* L.       | Fruit             | Methanol                    | 128–512 µg/mL        | 12.21–86.21%        | [49] |
| *Chamomilla recutita* (L.) Rauschert | Flowers         | Olive oil                   | 31.25–250 mg/mL      | Inhibited urease production | [105] |
| *Euphorbia umbellata* (Pax) Bruyns | Bark              | Methanol                    | 1024 µg/mL           | 78.6%               | [77] |
| *Peumus boldus* Mol.               | Leaves            | Water                       |                      | IC50 = 23.4 µg GAE/mL | [61] |
| *Terminalia chebula* Retz          | Fruit             | Water                       | 1–2.5 mg/mL          | Inhibited urease activity | [63] |

IC50, 50% inhibitory concentration. GAE, gallic acid equivalents.
7. Conclusions and Future Perspectives

Overall, the report suggests that the studied plant extracts possess anti-
\( H. \text{ pylori} \) activity, strengthening the claims made by traditional medicine practitioners about their putative anti-ulcerative properties. However, very few of them were investigated for efficacy in animal models or the ability to inhibit urease activity. Further studies are warranted for efficacy studies in animal models, elucidation of effective modes of action (including urease inhibition), and clinical trials in human being.

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