Scientia Pharmaceutica

Review

Ethnobotanical Review of Selected Medicinal Plants in Guam for the Treatment of Urinary Tract Ailments and Their Pharmacological Properties

Sahena Ferdosh

Western Pacific Tropical Research Center, College of Natural and Applied Sciences, University of Guam, Mangilao, GU 96923, USA; ferdoshs@triton.uog.edu; Tel.: +1-(671)-735-2144

Abstract: The Chamorro healers of Guam have more than a thousand years of history of using herbs and medicinal plants for the treatment of common ailments. The objective of this study is to review the bioactive compounds and pharmacological properties of medicinal plants which are used for urinary tract health by local healers. Literature searches were performed using Google Scholar, ScienceDirect, PubMed, and SpringerLink, by using several keywords, including "medicinal plants in Guam", "traditional uses", "bioactive compounds", "pharmacological properties", and "urinary tract infections". This review highlights the traditional uses, bioactive compounds, and pharmacological properties of five medicinal plant species, namely *Euphorbia hirta*, *Phyllanthus amarus*, *Premna serratifolia*, *Psidium guajava*, and *Urena lobata*. Phenolics, alkaloids, terpenoids, essential oils, and polypeptides are the leading secondary metabolites reported in different plant extracts, which have been found to have significant antimicrobial, antioxidant, anti-inflammatory, antidiabetic, and anticancer properties. The therapeutic claims made about medicinal plants in Guam are well supported by the literature, having similar applications and pharmacological properties in other regions of the world. These medicinal plants have a lot of unexplored potential that might be utilized to develop more potent drugs for the treatment of infectious diseases, as well as food and herbal supplements.

Keywords: medicinal plants; traditional uses; urinary tract infections; bioactive compounds; pharmacological properties

Citation: Ferdosh, S. Ethnobotanical Review of Selected Medicinal Plants in Guam for the Treatment of Urinary Tract Ailments and Their Pharmacological Properties. *Sci. Pharm.* **2023**, *91*, 43. https://doi.org/10.3390/scipharm91030043

Academic Editors: Sonia Piacente and Marta Menegazzi

Received: 7 July 2023
Revised: 10 August 2023
Accepted: 22 August 2023
Published: 1 September 2023

1. Introduction

Guam is the largest western Pacific tropical island of the United States and lies at 130 north latitude. The island is about 30 miles long and 4 to 12 miles wide, with a total area of 212 square miles, and is home to some 200 herbs and medicinal plants. Despite cultural adaptations associated with Spanish, American, and Asian culture, indigenous practices of healing and curing with medicinal plants by the Chamorro people of Guam have still survived in a modified form. Guam has a diverse range of plant groups, including limestone forests, wetland ecosystems, savannas, strands, and ravine forests. Many of these plant species have been used for centuries as herbal medicines and as preventative dietary supplements. These plants could be a potential source of new drugs to treat modern-day diseases, following extensive research involving the proper identification, phytochemical extraction, separation, and characterization of bioactive compounds. Medicinal plants have proven their therapeutic value for millennia and still hold out as the best options for finding active compounds. Over the past 50 years, the isolation and derivatization of numerous significant drugs from plants have revolutionized modern medicinal practice [1].

Currently, traditional healers of Guam treat minor ailments with massage, herbal medicines, and medicinal teas, as well as palai medicine that is applied to the skin [2]. Traditional medicine uses a variety of plant parts, such as the leaves, stems, and roots of a single plant or a combination of several plant species. One of the most typical illnesses that

indigenous healers address is urinary tract infections (UTIs). Several plant species have been identified by local healers for the preparation of herbal medicine to treat urinary tract problems [2].

Medicinal plants contain a wide variety of secondary metabolites, such as alkaloids, phenolic compounds, terpenoids, and sulfur-containing compounds, which have been found to have different pharmacological activities. Historically, bioactive compounds of plants have played a key role in drug discovery, especially for cancer and infectious diseases [3]. COVID-19 had a positive impact on herbal medicine studies. Recently, there has been an increase in the search for plant-based drugs and nutritional supplements. The number of publications on bioactive natural product studies has increased more than 3-fold during the past ten years, according to a recent search using the keywords, "Natural Product Research" in the ScienceDirect database. Thus, this paper reviews the plants grown in Guam used in traditional remedies for urinary tract problems and their reported pharmacological properties. The selected medicinal plants are *Euphorbia hirta*, *Phyllanthus amarus*, *Premna serratifolia*, *Psidium guajava*, and *Urena lobata* (Figure 1).

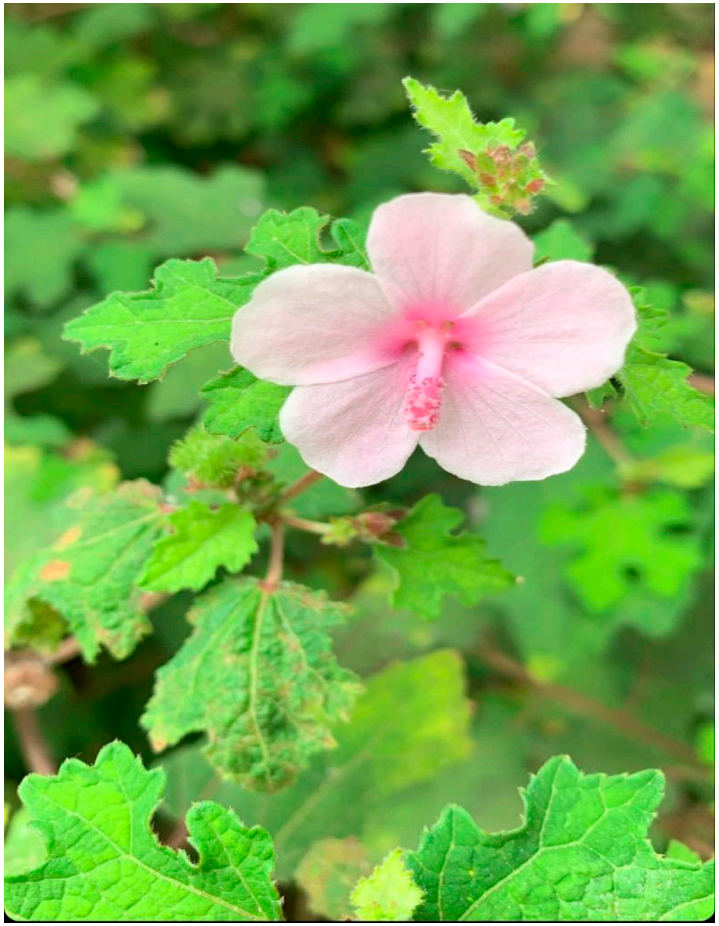
(**a**). *Euphorbia hirta*

(**b**). *Phyllanthus amarus*

(**c**). *Premna serratifolia*

Figure 1. *Cont*.

(**d**) *Psidium guajava*



(**e**) *Urena lobata*

Figure 1. (**a**–**e**): Photograph of selected medicinal plants in Guam for the treatment of urinary tract ailments.

2. Botanical Used for Urinary Tract Health in Guam

A urinary tract infection (UTI) is a bacterial infection that can affect any part of the urinary system, including the bladder, urethra, vagina, or kidneys. Common symptoms of UTIs include urinary urgency, frequency, discomfort above the pubic bone, and dysuria. UTIs are one of the most prevalent infections in women, occurring in 40% of women in the United States at some point in their lifetime [4]. The urinary pathogen, *Escherichia coli*, causes the vast majority (75–90% of isolates) of UTIs, followed by *Klebsiella pneumoniae*, whereas other bacteria including *Staphylococcus saprophyticus*, *Enterococcus faecalis*, *Proteus mirabilis*, and *Pseudomonas aeruginosa* are less important [4,5]. Although antibiotic medication is a successful method of treating UTIs, its side effects, particularly the emergence of resistant pathogenic strains, have increased interest in herbal therapies made from plant extracts.

Workman et al. [2] reported a list of healers in Guam who used several plant species for the preparation of herbal medicine to treat and prevent UTIs: (1) Mrs. De Jesus is one of the healers who prepared the *Psidium guajava* leaf infusion for a drink used to treat bladder infections. (2) Mr. Quinata and Mrs. Aguon both used the same recipe for a douche preparation which includes the leaves of *E. hirta*, *P. guajava*, and *P. amarus*. (3) To make vaginal douche for cleaning or after intercourse, Mr. Tan Red used the leaves of *P. guajava*, *Typhonium cuspidatum*, *and P. obtusifolia*. (4) To treat a vaginal infection, Mr. Tun Reyes prepared a douche mixture by using *Ruellia blechum*, *Cassia tora*, coconut oil, florida water and any tea. (5) Mrs. Mendiola boiled the leaves of *P. amarus*, *Artemisia vulgaris*, *E. hirta*, *P. guajava* with water, which were strained and cooled before being used as a vaginal douche. (6) Tan Maria used the leaves of *R. blechum*, *E. hirta*, *P. amarus*, *P. guajava* for douche preparation. She provided her douche to mothers after giving birth. (7) Mrs. Santos prepared douche from *E. hirta*, *P. amarus*, *R. blechum*, *P. guajava*, *A. vulgaris*. (8) For kidney problems, Mrs. Tan Ana prescribed drinks prepared with dried Zea mays, the leaves of *Lagerstroemia speciosa*, the root of *Ficus prolixa*, leaves of *Persea americana*, *Hibiscus tiliaceus* and *Aloe vera*, and coconut oil mashed, boiled, strained, and sipped like tea.

Manglona [6], another local healer of Guam, recently prepared herbal medicine for cleansing the body with the leaves, stems, and roots of 11 plant species, namely *Randia cochinchinensis*, *Cassia occidentalis*, *Columbrina asiatica*, *Deeringia amaranthoides*, *Erythrina variegate*, *Maytenus thompsonii*, *Melanolepis multiglandulosa*, *Phymatodes scolopendria*, *Pandanus tectorius*, and *Premna obtusifolia*. According to her recommendation, patients who exhibit the symptoms of painful urination, blood in the urine, kidney infections, back discomfort, and inability to completely empty their bladders can consume herbal extract at a dose of two full cups each day for seven days. One cup in the morning after waking up and one cup in evening before sleep. She prepared her herbal extract by boiling the leaves, stems, and roots of plants in a cooking pot with two gallons of water for 45 min [6]. This traditional practice is still utilized quite often within the local community as an alternative to modern medicine.

Nandwani et al. [7] reported several medicinal plants/parts used for the treatment of urinary tract problems in the Northern Mariana Islands, namely the leaves and roots of *Pandanus tectorius*, *R. blechum*, *Deeringia amarantoides*, *Ipomea pes-caprae*, *Scaevola sericea,* and *Wedelia biflora*; the leaves of *U. lobata*, *Maytenus thompsonii*, *Davallia solida*, *Terminalia catappa*, *E. hirta*, *P. amarus*, *Psychotria mariana*, and *Piper betle*; the leaves and bark of *Erythrina variegate*; the leaves and fruits of *P. guajava* and *Barringtonia asiatica*; the leaves, bark, and trunks of *H. tiliaceus*. Cowan [8] reported about 100 medicinal plant products from North America that contain antimicrobial agents. Major classes of phytochemicals that have antibacterial, antiviral, and antifungal properties are phenolics, terpenoids, alkaloids, essential oils, lectin and polypeptides, and polyacetylenes. The author also reported several bioactive compounds responsible for antimicrobial activities which include eugenol, berberine, catechols, piperine, tannins, capsaicin, allicin, gallic acid, epicatechin, cinnamic acid, hypericin, chrysin, abyssinone, totarol, ellagitannin, warfarin, capsaicin, fabatin, and many other.

Many of the herbs that are used in traditional medicine around the world have been studied in vitro and in clinical trials for the treatment of UTIs. According to Tache et al. [9], Pomegranate (*Punica granatum* L.), black chokeberry (*Aronia melanocarpa* Michx.), and cornelian cherry (*Cornus mas* L.) have great potential to be used for prevention or in a combined antibiotic therapy to cure UTIs. Pomegranate peel extracts, with the chemical composition of phenolics (gallic acid, caffeic acid, benzoic acid, cinnamic acid) and flavonoid compounds, have shown antibacterial activity against Enterobacteriaceae [*Escherichia coli*, *Salmonella typhimurium* and *Shigella dysenteriae*] and Gram-positive bacterium [*Staphylococcus aureus*] [10]. The ripe fruit, stems, and leaf extracts of Black chokeberry contain a variety of bioactive compounds such as anthocyanins, epicatechin, quercetin, kaempferol-3-O-rutinoside, and hydroxytyrosol, which have been found to strongly inhibit the bacterial growth of *E. coli* in vitro [9]. The authors also reported that the leaf extracts of Cornelian cherry contain iridoids, ellagic acid, and ellagic-tannins, acted as bacteriostatic agents against *E. coli*. Das [11] listed 36 ethnomedicinal plants used for the treatment of UTIs and 80 medicinal plants with anti-uropathogenic potential. According to her study, *Vaccinium macrocarpon* (cranberry) is the best-studied home remedy for UTIs. Proanthocyanins found in cranberries can inhibit bacteria from attaching to urinary tract walls, hence obstructing the progression of uropathogenesis [11].

3. Mechanisms of Action of Bioactive Compounds

Medicinal plants synthesize secondary metabolites in response to an infection (induced defense), which act as antibiotics against pathogenic microorganisms. Plant root exudates contain bacteriostatic compounds such as coumaric acid, 3-indol propionic acid, and methyl p-hydroxybenzoate, which can make a plant resistant to pathogens. Plants produce defense aggressive oxygen compounds such as superoxide radicals ($\bullet O_{2-}$) and H_2O_2, as well as nitrogen monoxide (NO), and enzymes, such as β-glucanases, chitinases, and proteinases, which damage the cell walls of bacteria and fungi [12]. These antibacterial compounds found in herbal medicines could prevent or treat infections in humans. The antibacterial activities of these bioactive compounds are primarily mediated by two basic mechanisms: chemically interfering with the synthesis or function of essential bacterial components and/or evading the known antibacterial resistance mechanisms through (I) bacterial protein biosynthesis; (II) bacterial cell-wall biosynthesis; (III) bacterial cell membrane destruction; (IV) bacterial DNA replication and repair; and (V) inhibition of the metabolic pathway [13]. The leaves of *Arctostaphylos uva-ursi* (bearberry) contain glycoside arbutoside; after consumption, it is first hydrolyzed in the gut to aglycone hydroquinone then carried to the kidneys and excreted in the urine. In the alkaline condition of urine, hydroquinone will be released to act as a direct antimicrobial agent [14]. The leaf and berries of *Juniperus communis* (juniper) contain terpenoids which have antibacterial and diuretic activities [14]. Proanthocyanidins, which are present in *Vaccinium macrocarpon* (cranberry) juice, are effective against *E. coli*, one of the main causes of bacteria-mediated UTIs, by preventing the bacteria from adhering to the bladder walls. As a result, the bacteria are more likely to be washed away during urination [15]. *Cinnamomum verum* contains the essential oil, trans-cinnamaldehyde, and can prevent the growth of biofilm *E. coli* on urinary catheters by inhibiting the expression of key virulence genes in the bacterium [16]. Isothiocyanates are an active constituent found in *Armoracia rusticana* (horseradish) that can block the uropathogenic *E. coli* from penetrating human cells [17].

4. Bioactive Compounds and Pharmacological Properties of Selected Medicinal Plants

Table 1 lists selected medicinal plants in Guam for urinary tract ailments and their major bioactive compounds and pharmacological properties.

Table 1. Literature-based proof of phytochemicals and pharmacological activities of selected herbs and medicinal plants in Guam.

Botanical Name	Local Name	Chemical Constituents	Reported Pharmacological Activities in Different Plant Parts
Euphorbia hirta	Golundrina	Leaves: tannins, saponins, steroids, terpenoids, flavonoids, triterpenoids, polyphenol, glycoside, anthocyanins, and coumarins [18].	Leaves: antimicrobial [19–22]; anti-inflammatory [23]; anticancer [24]; antioxidant and antifungal [25].
Phyllanthus amarus	Maigo' Lålo'	Leaves and roots: saponins, tannins, phenolics, anthocyanins, alkaloids, triterpenoids, and glycosides, steroids, flavonoids, and coumarins [26].	Leaves: antibacterial [27–29]; antiviral, antibacterial, antiplasmodial, anti-inflammatory, antimalarial, antimicrobial, anticancer, antidiabetic, hypolipidemic, antioxidant, hepatoprotective nephroprotective, and diurectic properties [30].
Premna obtusifolia	Å hgao	Leaves: flavonoids, saponins, tannins, and triterpenoids/steroids [31].	Antibacterial [32], Anticancer [33]; Antioxidant, antiarthritic, anticholesterol, anti-inflammatory, antimicrobial, antihelmintic, antidiabetic, and anticancer/cytotoxic [31].
Psidium guajava	Åbas	Leaves: carbohydrates, proteins and amino acids, carotenoids, flavonoids, alkaloids, polyphenols, saponins, tannins, glycosides, and sterols [34].	Leaves: antidiabetic [35,36]; antioxidant [37,38]; anti diarrhoeal [39,40]; antibacterial [38,41]; anticancer [42,43].
Urena lobata	Dadangse Ahgaga	Leaves: flavonoids, alkaloids, steroids, saponins, and tannins [44].	Leaves: antimicrobial [44]; antiarthritic activity [45]; analgestic and anti-inflammatory activity [46]; antidiabetic [47].

4.1. *Euphorbia hirta*

Euphorbia hirta—commonly known as asthma-plant, barok, or pill-bearing spurge—belongs to the Euphorbiaceae family. It is one of the common annual herbaceous plants in Guam and considered as a weed that is native to tropical and subtropical regions, including Asia, Africa, and the Americas. Traditional healers of Guam have used the leaf extracts of *E. hirta* for an astringent douche mixture and the treatment of headaches for long a time [2]. Most of its traditional uses involve taking the extract of *E. hirta* orally as an aqueous decoction. *E. hirta* has been used since ancient times as a popular medicinal herb in several parts of the world to treat urinary tract infections; to relieve gastrointestinal disorders such as diarrhea and dysentery; and to treat respiratory conditions such as asthma, coughs, bronchitis, and pneumonia.

E. hirta contains various secondary metabolites which contribute to its potential therapeutic properties. Ethanol extracts of *E. hirta* leaves and roots contain a diverse range of bioactive compounds, including alkaloids, glycosides, flavonoids, tannins, and phenolics [23]. Aqueous, ethanol, and methanol extracts of *E. hirta* leaves contain tannins, saponins, steroids, terpenoids, flavonoids, triterpenoids, polyphenol, glycoside, anthocyanins, and coumarins [18]. Many research investigations have thoroughly documented the biological properties of *E. hirta* extracts, which include antibacterial, antimalarial, anti-inflammatory, antidiarrheal, and antioxidant activities (Table 1). Subramani et al. [19] reported antibacterial and antifungal activity against common oral pathogens such as *S. mutans* (ZOI = 11 ± 0.54 mm), *Lactobacillus acidophilus* (ZOI = 10 ± 0.04 mm), *E. coli* (ZOI = 13 ± 0.05 mm), and *C. albicans* (ZOI = 14 ± 0.59 mm) at a concentration of 5 mg/mL. Ethanol leaf extract exhibited significant anti-inflammatory activity compared to roots by inhibiting albumin denaturation, proteinase, and lipoxygenase activity, with 87.51% and 51.2%, followed by 97.30% and 54.21%, followed by 94.43% and 48.21%, respectively, at a concentration of 100 lg/mL [23]. Sulaiman et al. [24] studied major groups of secondary

metabolites of *E. hirta* such as phenolics, flavonoids, and sterols, which showed significant dose-dependent anticancer activity against Ehrlich-ascites-carcinoma-induced periotoneal ascites in mice. The ethanol extract of leaves exhibited higher ABTS (1338.3 ± 85.3 and 802.3 ± 91.0 mmol ascorbic acid equivalent/gram of dry extract, respectively) and superoxide anion (2014.6 ± 78.6 and 1528.0 ± 111.7 mmol ascorbic acid equivalent/gram of dry extract, respectively) scavenging abilities than the water extract [25]. They also showed a remarkable antifungal effect against *Fusarium oxysporum f. sp. vasinfectum*, *Alternaria solani*, and *Rhizoctonia solani*. Different *E. hirta* Linn. extracts, including methanol, petroleum ether, chloroform, ethyl acetate, and butanol, were tested for their anticancer, antioxidant, and antibacterial activity by Tran et al. [20]. Ethyl acetate extracts showed the strongest antioxidant activity compared to other extracts with DPPH radical scavenging assay and lipid peroxidation inhibition assay (IC50 = 10.33 ± 0.01 µg/mL; IC50 = 1.48 ± 0.12 µg/mL, respectively). The extracts (100 µg/mL) also showed significant inhibitory activity against the growth of lung cancer cells NCI-H460 and liver cancer cells Hep G2. The authors also proved the strongest antibacterial activity of ethyl acetate extracts, compared to other extracts, against *B. subtilis*, *E. coli*, *S. aureus*, *P. aeruginosa*, *S. preumoniae*, *S. typhi*, *Vibrio cholearea*, *Shigella flexneri* [20]. In another study, Tran et al. [21] reported the antidiabetic activity of spray-dried bioactive compounds from *E. hirta* extracts. The spray powder was inhibited at 51.19% α-amylase at 10 mg/mL and reduced by 51% in fasting blood glucose (FBG) after 4 h of treatment. Additionally, the administration of spray powder for 15 days significantly decreased the fasting blood glucose level in streptozotocin-diabetic mice by 23.32%—compared to distilled water and the typical antidiabetic drug, acarbose, which both decreased the level by 30.87% and 16.89%, respectively [21]. The antimicrobial properties of *E. hyssopifolia* and *E. hirta*, against pathogens complicit in wounds, typhoid and UTIs, were studied by Alisi and Abanobi [22]. They reported the IC50 for *E. hirta* against *S. typhi* and *E. coli* was 99.67 µg/mL, and 165.90 µg/mL with no significant inhibition against *S. aureus*, implicated in typhoid fever and urinary tract infections.

4.2. Phyllanthus amarus

Phyllanthus amarus (Schum and Thonn) is one of the most pharmacologically important species of the Euphorbiaceae family commonly found in the tropical areas of the Americas, Africa, Southeast Asia, and China. In Guam, the leaves of *P. amarus* have been used in herbal medicine for the treatment of urinary tract problems, the preparation of an astringent douche, and the treatment of diarrhea, chapped lips, headache, infant teething, sore throats, coughs, and asthma [2]. It is an important plant of the Indian Ayurvedic system of medicine, which is used in treating problems of the stomach, genitourinary system, liver, kidney, and spleen. Ajayi et al. [48] analyzed multiple bioactive compounds in mg/100 g of leaf extract as phenol (34.31 ± 0.07), tannin (21.15 ± 0.16), phlobatanin (26.36 ± 0.19), terpernoid (14.71 ± 0.14), steroid (20.37 ± 0.13), cardiac glycoside (20.15 ± 0.19), alkaloid (23.90 ± 0.05), 9,12,15-octadecatrienoic acid, ethyl ester (Z,Z,Z)-(22.47%), benzenamine, N-[2-(3,4-dimethoxyphenyl)ethyl]-2-nitro-(12.68%), hexadecanoic acid, ethyl ester (12.63%), beta tocopherol (12.63%), and phytol (12.61%). The phytochemical concentrations in its leaves are 0.73 ± 0.01%, 1.85 ± 0.03%, 1.12 ± 0.01%, 1.80 ± 0.01%, 1.59 ± 0.50%, 0.13 ± 0.10%, and 0.86 ± 0.01%, for saponins, tannins, phenolics, anthocyanins, alkaloids, triterpenoids, and glycosides, respectively, while in the roots, they are are 0.91 ± 0.01%, 1.53 ± 0.03%, 0.70 ± 0.01%, 2.97 ± 0.10%, 2.47 ± 0.03%, 0.62 ± 0.01%, 0.90 ± 0.01%, and 2.02 ± 0.10% for saponins, tannins, phenolics, steroids, flavonoids, anthocyanins, glycosides, and coumarins, respectively [26]. The bioactive compounds of *P. amarus* retain multiple pharmacological activities including antiviral, antibacterial, antiplasmodial, anti-inflammatory, antimalarial, antimicrobial, anticancer, antidiabetic, hypolipidemic, antioxidant, hepatoprotective nephroprotective, and diuretic properties [30]. The methanolic extracts of *P. amarus* leaf extract have been found to exhibit higher antimicrobial activity against *E. coli*, *S. aureus*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *S. typhi*, and fungi including *Candida albicans*, *Malazessia furfur*, and *Aspergillius flavus* [27]. The minimum in-

hibitory concentration of methanol extracts against test microbes ranged from 6.25 mg/mL to 50 mg/mL, whereas the minimum bactericidal concentration ranged from 25 mg/mL to 100 mg/mL and the minimum fungicidal concentration was observed in the range of 25 mg/mL to 50 mg/mL [27]. In another study hexane extract of *P. amarus*, its leaves exhibited antifungal activity on *C. albicans*, while methanol extract exhibited significant antibacterial activity against *P. aeruginosa* and *S. aureus* at all concentrations of the extract between 12.5 and 100 mg/mL [28]. *P. amarus* extracts was found to contain saponins, flavonoids, alkaloids, tannins, phlobatanins, and terpenoids, which exhibited antibacterial activities against urinary tract pathogens (*Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Klesiella pneumonia*, *Enteroccocusfeacalis*, *Proteus mirabillis*, *Staphylococcus saprophytic*), which justifies the folk use of this plant as a treatment for UTIs [29].

4.3. Premna obtusifolia/serratifolia

Premna serratifolia is an evergreen shrub or small tree in the Lamiaceae family that can grow up to 7 m tall. It is one of the 200 species native to tropical and subtropical regions, including the Marianas. Leaf extracts of this plant have been traditionally used for the treatment of coughs, asthma, colds and flu, ear infections, hemorrhaging, and all types of illness [2], as well as urinary tract ailments [6]. Khairunnisa et al. [31] listed several bioactive compounds of *P. serratifolia* extracts, including flavonoids, saponins, tannins, and triterpenoids/steroids, which exhibit both in vitro and in vivo biological activities, such as antioxidant, antiarthritic, anticholesterol, anti-inflammatory, antimicrobial, antihelmintic, antidiabetic, and anticancer/cytotoxic activity. The antibacterial activity of *P. serratifolia* essential oil against *S. aureus* and *S. typhi* showed weak inhibition wherein the diameter of the clear zone was 4.6 mm for *S. aureus* and 4.7 mm for *S. typhi*, at a concentration of 100% [32]. Major bioactive compounds such as phytol (27.25%), α-humulene (14.21%), spathulenol (12.12%), 1-octen-3-ol (8.21%), eugenol (6.69%), and phenyl ethyl alcohol (5.81%) were reported by Rahman et al. [49] from *Premna integrifolia* Linn extracts, which displayed great potential of antibacterial activity against *Sarcina lutea*, *B. subtilis*, *E. coli*, *Pseudomonas* sp., *K. pneumoniae*, and *Xanthomonas campestries* with their respective zones of inhibition of 12.0 ± 1.2 to 22.1 ± 1.2 mm and MIC values of 62.5–250 μg mL^{-1}. The cytotoxic potential of the aquas root extract of *P. serratifolia* was analyzed via MTT assay, and was found to have an IC50 value of 1000 μg/mL after 48 h of incubation [33]. The greatest antimicrobial activity was exhibited by an n-hexane fraction (MIC 10 μg/mL) of *P. resinosa* extract against *S. aureus*, *E. faecalis*, and *Shigella flexneri* and cytotoxic activity against Daoy, HepG2, and SK-MEL28 cell lines with IC50 values of 9.0, 8.5, and 13.2, respectively [50]. The authors identified seven compounds for the first time, namely, quercetin, 3-methoxy quercetin, kaempferol, 3-methoxy kaempferol, myricetin 3,7,30-trimethyl ether, lupeol, and stigmasterol, which might be responsible for the anticancer, antimicrobial, and antioxidant activities of *P. resinosa*. Specific studies of *P. serratifolia* extract against uropapthogens were not found.

4.4. Psidium guajava

Psidium guajava (L.) is a tropical food plant belonging to the Myrtaceae family, widely used in the traditional medicine for the treatment of various diseases such as diarrhea, diabetes, rheumatism, ulcers, malaria, cough, and bacterial infections [51]. Different parts (leaves, stems, barks, roots, and fruits) of *P. guajava* have a unique application in different parts of the world. The leaves have been used in Guamanian folk medicine as a traditional herbal remedy for bladder infections, a vaginal douche, cleansing wounds, skin rashes, gastroenteritis, and back pain [2,7]. Ugbogu et al. [51] listed multiple bioactive compounds found in the leaves of *P. guajava*, including gallic acid, pedunculagin, casuariin, prodelphinidin, catechin, chlorogenic acid, rutin, vanillic acid, quercetin, p-hydroxyl benzoic acid, syringic acid, kaempferol, apigenin, cinnamic acid, luteolin, reynoutrina, morin, ellagic acid, guavinoside B, myrciaphenone B, vescalagin, castalagin isomer, hyperoside, guaijaverin, ursolic acid, oleanolic acid, methyl gallate, procyanidin. These bioactive compounds

exhibited different pharmacological properties such as antidiabetic, anti-inflammatory, antioxidant, antifungal, antibacterial, neuroprotective, cardioprotective, and anticancer activities. Zhu et al. [35] identified two major antidiabetic compounds, guaijaverin and avicularin, in guava leaf flavonoids, which showed significant hypoglycemic, hypolipidemic, and liver-protective effects.

The half-maximal inhibitory concentration of guava leaves for DPPH, ABTS, and β-carotene bleaching tests are IC50 = 17.66 ± 0.07 μg/mL, IC50 = 19.28 ± 0.03 μg/mL, and IC50 = 3.17 ± 0.01 μg/mL, respectively [38]. The leaf extracts have also shown significant antibacterial activity against *Streptomyces acidiscabies* (MIC = 1.25 μg/mL), *Ralstonia solanacearum* (MIC = 5 μg/mL), and *Erwinia carotovora* subsp carotovora borgey (MIC = 2.5 μg/mL). Hirudkar et al. [40] assessed the antidiarrheal properties of *P. guajava* extracts against enteropathogenic *Escherichia coli* in rats. Zhu et al. [43] identified three compounds—guavinoside E, 3,5-dihydroxy-2,4-dimethyl-1-O-(6′-O-galloyl-β-D-glucopyranosyl)-benzophenone, and guavinoside B— as exhibiting anticancer activity against HCT116 and HT29 cells. Psidinone, a bioactive compound isolated from *P. guajava* leaves, was found to exhibit antibacterial activity against *S. aureus*, *S. epidermidis*, and *Mycobacterium Smegmatis*, with minimum inhibitory concentrations of 16, 8, and 0.5 μM, respectively [41]. The leaf and stem extracts (ethanolic and aqueous) of *P. guajava* have shown antibacterial activity against *S. aureus* isolates from UTI patients, with varying mean zones of inhibition ranging from 10 mm to 24 mm [52].

4.5. Urena lobata

Urena lobata belongs to the Malvaceae family and is an erect shrub that grows up to 3 m (10 feet) in height. This plant has long been used as a traditional medicine to treat UTIs [6,7], ear infections, sore throat, cough, asthma, and as an antipyretic [2] by the local healers of Guam. Its leaves, stem bark, roots, and flowers are useful for treating injuries, fever, infections, inflammation, and diarrhea [46]. The leaves of the plant exhibit antimicrobial [44], antiarthritic [45], analgesic, and anti-inflammatory activity [46]. Preliminary phytochemical screenings have demonstrated the presence of flavonoids, alkaloids, steroids, saponins, and tannins, which led to the isolation of β-sitosterol, β-sitosterol-3-O-β-D-glucopyranoside, 2-acetylamino-3-phenylpropyl 2-benzoylamino-3-phenylpropanoate, quercetin, and trans-tiliroside [53]. Keke et al. [54] reported 41 bioactive compounds from ethanolic leaf extracts of *U. lobata*, with the following being most abundant: 9-octadecenoic acid (16.8%), dodecenoic acid (13.43%), n-hexadecanoic acid (11.73%), octadecanoic acid (9.78%), 1-docosene (9.57%). The leaves have shown antibacterial activity against *S.typhi* and *S. mutans*, with inhibition zone diameters of 7.05 mm and 8.25 mm, respectively [44]. The ethanolic extract of *U. lobata* leaves have shown stronger antidiabetic potential through dipeptidyl peptidase IV (DPP-IV) inhibitory activity, with IC50 values of 1654.64, due to its active compounds such as mangiferin, stigmasterol, and β-sitosterol [47]. The antibacterial activity of *U. lobata* leaf extracts against uropathogens were studied by Garuba et al. [55], who observed the highest zone of inhibition against *E. coli*, *Bacillus cereus*, *Streptococcus pneumoniae*, and *Brevibacillus panacihumi*. The toxicity test results showed that the acetone extract of *U. lobata* leaves was toxic, with an LC50 value of 37.20 ppm [44].

5. Extraction of Bioactive Compounds from Selected Medicinal Plants

Extraction is the essential first step in the analysis of natural products that leads to further separation, identification, and characterization. Extraction methods are classified into two main categories: conventional and non-traditional. Conventional extraction methods include maceration, percolation, decoction, reflux extraction, soxhlet extraction, and hydro/Steam distillation. Despite their widespread use, conventional procedures have significant drawbacks such as long extraction procedures, low extraction yield, reduced selectivity, degradation of heat-labile compounds, and the use of hazardous toxic organic solvents. To address the shortcomings of conventional methods, several non-conventional methods have been introduced, including supercritical fluid extraction, ultrasound-assisted

extraction, microwave-assisted extraction, enzyme-assisted extraction, pulsed electric field extraction, and pressurized liquid extraction [56]. Different extraction methods and solvents used for extracting bioactive compounds from medicinal plants are given in Table 2.

Table 2. Methods and solvents used for extracting bioactive compounds from medicinal plants.

Plants Species	Parts of Plant	Extraction Method and Solvent Used	Study Design	Reference
Euphorbia hirta	Aerial part	Maceration: ethanol	In vitro antimicrobial study against uropathogens	[22]
	Aerial part	Soxhlet: ethanol	In vitro antimicrobial effect on oral pathogens	[19]
	Leaves	Maceration (cold extraction): methanol, ethanol, hexane and aqueous	Evaluation of bioactive compounds	[18]
Phyllanthus amarus	Seeds and leaves	Maceration: methanol, ethanol, acetone, and hot water	Drug properties and antimicrobial evaluations	[27]
	Leaves	Maceration (cold extraction): methanol, n-hexane, and ethylacetate.	In vitro antimicrobial properties	[28]
Premna serratifolia	Roots	Maceration (cold extraction): aqueous	Phytochemical profiling and cytotoxic evaluation	[33]
	Leaves	Infusion and decoction: hot water	In vitro antidiabetic and antioxidant activities	[57]
Psidium guajava	Leaves and stem back	Maceration: ethanol and water	In vitro antibacterial activity for urinary tract infections	[52]
	Leaves	Maceration: ethanol, ethyl acetate, and water	Antihyperglycemic and liver-protective effects	[35]
Urena lobata	Leaves	Soxhlet: methanol and distilled water	Antibacterial activity against uropathogens	[55]
	Leaves	Maceration: acetone	In vitro antibacterial activity	[44]

Maceration is the most common method used for the extraction of bioactive compounds from medicinal plants (Table 2). Fresh aerial parts of *E. hirta* were dried at 30 °C, then reduced to a coarse powder in a mill and extracted with ethanol via shaking for 48 h [22]. A sample of the air-dried, pulverized leaves of *P. amarus* was cold extracted in distilled n-hexane, ethyl acetate, and methanol separately for 3 days, each by agitating and decanting for three successive extractions. Then, the extracts were filtered using Whatman filter paper, and the filtrate was evaporated using a rotatory evaporator [28]. Singh et al. [33] used fresh roots for their study. After chopping the fresh root into small pieces, heating at 60 °C in 100 mL deionized water for 20 min, and after cooling, it was filtered through Whatman No.1 filter paper [33]. Soxhlet extraction with methanol and distilled water as solvent was used to extract bioactive compounds from the leaves of *U. lobata* for a study of its antibacterial activity against uropathogens [55].

6. Conclusions

This review summarizes the reported bioactive compounds and pharmacological properties of seven plant species used traditionally in Guam to treat ailments of the urinary tract. Very limited research on screening phytochemicals and pharmacological activity has been reported for *P. serratifolia*. Other species such as *E. hirta*, *P. amarus*, *U. lobata*, and *P. guajava* have been found to be effective against *E. coli* strains, which cause the majority of UTIs. The antibacterial properties of plant extracts, which include tannins, saponins, steroids, terpenoids, flavonoids, triterpenoids, polyphenols, glycosides, anthocyanins, and coumarins, are thought to be responsible for the traditional treatment of UTIs. However,

none of these Guam-grown plant species have been investigated for their phytochemical components and pharmacological properties yet. To identify all potential bioactive compounds responsible for pharmaceutical activity and their mechanisms, it is necessary to screen medicinal plants for therapeutic potential. Additional molecular-level research should also be performed. The isolation and characterization of bioactive compounds, the evaluation of their clinical safety, and the validation of their traditional uses may offer new opportunities in scientific research for the discovery of new drugs and the development of herbal supplements.

Funding: This study was funded by the USDA NIFA Research Capacity Fund (Hatch) (Accession no. 7005056).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: Author would like to thank Jessica Nangauta (Triton farm, UOG) and Manglona, a local healer, for sharing their knowledge on the traditional uses of medicinal plants in Guam.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Newman, D.J.; Gordon Cragg, M.G. Natural products as sources of new drugs over the nearly four decades from 01/1981 to 09/2019. *J. Nat. Prod.* **2020**, *83*, 770–803. [CrossRef]
2. Workman, A.P.; Ortiz, L.C.; Quinata, D.K. The Use of traditional medicine & healers on Guam: Suruhånas, Suruhånos yan i Che'cho niha. In *Science of Pacific Island Peoples: Fuana, Flora, Food and Medicine*; Morrison, J., Geraghty, P., Crowl, L., Eds.; Institute of Pacific Studies, University of the South Pacific: Suva, Fiji, 1994; Volume 3.
3. Atanasov, A.G.; Zotchev, S.B.; Dirsch, V.M.; Supuran, C.T. Natural products in drug discovery: Advances and opportunities. *Nat. Rev. Drug Discov.* **2021**, *20*, 200–216. [CrossRef] [PubMed]
4. Bono, M.J.; Leslie, S.W.; Reygaert, W.C. Urinary tract infection. In *StatPearls [Internet]*; StatPearls Publishing: Treasure Island, FL, USA, 2022.
5. Sheerin, N.S.; Glover, E.K. Urinary tract infection. *Medicine* **2019**, *47*, 546–550. [CrossRef]
6. Manglona, L.T. MAFA'TINAS I ÅMOT SIHA: Åmot CHamoru Presentation and Demonstration. *Leaflet* **2023**.
7. Nandwani, D.; Calvo, J.A.; Tenorio, J.; Calvo, F.; Manglona, L.T. Medicinal plants and traditional knowledge in the Northern Mariana Islands. *J. Appl. Biosci.* **2008**, *8*, 323–330.
8. Cowan, M.M. Plant products as antimicrobial agents. *Clin. Microbiol. Rev.* **1999**, *12*, 564–582. [CrossRef]
9. Tache, A.M.; Dinu, L.D.; Vamanu, E. Novel insights on plant extracts to prevent and treat recurrent urinary tract infections. *Appl. Sci.* **2022**, *12*, 2635. [CrossRef]
10. Mahmood, M.S.; Ashraf, A.; Ali, S.; Siddique, A.B.; Asad, F.; Abbas, R.Z.; Rafique, A. Portrayal of *Punica granatum* L. peel extract through high performance liquid chromatography and antimicrobial activity evaluation. *Braz. J. Biol.* **2021**, *83*, e244435. [CrossRef]
11. Das, S. Natural therapeutics for urinary tract infections—A review. *Future J. Pharm. Sci.* **2020**, *6*, 64. [CrossRef] [PubMed]
12. Heldt, H.-W.; Piechulla, B. *Plant Biochemistry*, 5th ed.; Academic Press: Cambridge, MA, USA, 2021; ISBN 978-0-12-818631-2. [CrossRef]
13. Khameneh, B.; Iranshahy, M.; Soheili, V.; Bazzaz, B.S.F. Review on plant antimicrobials: A mechanistic viewpoint. *Antimicrob. Resist. Infect. Control* **2019**, *8*, 118. [CrossRef] [PubMed]
14. Yarnell, E. Botanical medicines for the urinary tract. *World J. Urol.* **2002**, *20*, 285–293. [CrossRef] [PubMed]
15. Bazzaz, B.S.F.; Fork, S.D.; Ahmadi, R.; Khameneh, B. Deep insights into urinary tract infections and effective natural remedies. *Afr. J. Urol.* **2021**, *27*, 6. [CrossRef]
16. Amalaradjou, M.A.R.; Venkitanarayanan, K. Natural approaches for controlling urinary tract infections. In *Urinary Tract Infections*; Tenke, P., Ed.; InTech: New York, NY, USA, 2011; pp. 227–244.
17. Mutters, N.T.; Mampel, A.; Kropidlowski, R.; Biehler, K.; Günther, F.; Bălu, I.; Malek, V.; Frank, U. Treating urinary tract infections due to MDR *E. coli* with Isothiocyanates—A phytotherapeutic alternative to antibiotics? *Fitoterapia* **2018**, *129*, 237–240. [CrossRef]
18. Sudha, T.S.; Padmini, R. Evaluation of bioactive compounds in *Euphorbia hirta* Linn. leaves extract using gas chromatographic and mass spectroscopic techniques. *J. Pharm. Negat. Results* **2023**, *14*, 1988–1995.
19. Subramani, P.; Murugappan, S.; Ganesh, G.; Mani, D.; Jones, S.C. Antimicrobial effect of *Euphorbia hirta* on common oral pathogens: In Vitro Study. *J. Sci. Dent.* **2022**, *12*, 5–7.

20. Tran, N.; Nguyen, M.; Le, K.P.; Nguyen, N.; Tran, Q.; Le, L. Screening of antibacterial activity, antioxidant activity, and anticancer activity of *Euphorbia hirta* Linn. Extracts. *Appl. Sci.* **2020**, *10*, 8408. [CrossRef]
21. Tran, N.; Tran, M.; Truong, H.; Le, L. Spray-drying microencapsulation of high concentration of bioactive compounds fragments from *Euphorbia hirta* L. extract and their effect on diabetes mellitus. *Foods* **2020**, *9*, 881. [CrossRef]
22. Alisi, C.S.; Abanobi, S.E. Antimicrobial properties of *Euphorbia hyssopifolia* and *Euphorbia hirta* against pathogens complicit in wound, typhoid and urinary tract infections. *Int. J. Trop. Dis. Health* **2012**, *2*, 72–86. [CrossRef]
23. Das, K.; Asdaq, S.M.B.; Khan, M.S.; Amrutha, S.; Alamri, A.; Alhomrani, M.; Harshitha, P. Phytochemical investigation and evaluation of in vitro anti-inflammatory activity of *Euphorbia hirta* ethanol leaf and root extracts: A comparative study. *J. King Saud Univ. Sci.* **2022**, *34*, 102261. [CrossRef]
24. Sulaiman, C.T.; Deepak, M.; Praveen, T.K.; Lijini, K.R.; Salman, M.; Sadheeshnakumari, S.; Balachandran, I. Metabolite profiling and anti-cancer activity of two medicinally important *Euphorbia* species. *Med. Omics.* **2023**, *7*, 100018. [CrossRef]
25. Mekam, P.N.; Martini, S.; Nguefack, J.; Tagliazucchi, D.; Stefani, E. Phenolic compounds profile of water and ethanol extracts of *Euphorbia hirta* L. leaves showing antioxidant and antifungal properties. *S. Afr. J. Bot.* **2019**, *127*, 319–332. [CrossRef]
26. Ameen, O.A.; Hamid, A.A.; Yusuf, Q.; Njoku, O.G.; Oseni, T.O.; Jamiu, W. Quantitative and qualitative assessment of phytochemicals in methanolic extracts of hurricane weed (*Phyllanthus amarus* Schumach. & Thonn) Plant. *J. Appl. Sci. Environ. Manag.* **2021**, *25*, 159–165.
27. Okiki, P.A.; Egbebi, A.; Akharaiyi, F.C.; Adewole, E.; Asoso, S.O. Drug properties and antimicrobial evaluations of extracts from *Phyllanthus amarus*. *J. Microbiol. Exp.* **2022**, *10*, 10–16. [CrossRef]
28. Zubair, M.F.; Atolani, O.; Ibrahim, S.O.; Adebisi, O.O.; Hamid, A.A.; Sowunmi, R.A. Chemical constituents and antimicrobial properties of *Phyllanthus amarus* (Schum & Thonn). *Bayero J. Pure Appl. Sci.* **2017**, *10*, 238–246.
29. Oladosu, S.A.; Coker, A.O.; Nwaokorie, F. Antibacterial effects of *Phyllantus amarus* on urinary tract pathogens. *Int. Clin. Pathol. J.* **2019**, *7*, 1–10.
30. Patel, J.R.; Tripathi, P.; Sharma, V.; Chauhan, N.S.; Dixit, V.K. *Phyllanthus amarus*: Ethnomedicinal uses, phytochemistry and pharmacology: A review. *J. Ethnopharmacol.* **2011**, *138*, 286–313. [CrossRef]
31. Khairunnisa, K.Q.; Febriyanti, R.M.; Muhaimin, M. Phytochemistry and pharmacological potentials of *Premna serratifolia* L.: Traditional medicinal plant used by local people in Kalimantan. *Indonesian J. Biol. Pharm.* **2022**, *2*, 178–188. [CrossRef]
32. Nursin, N.; Nurliana, L.; Imran, I.; Musta, R. Uji Aktivitas antibakteri staphylococcus aureus dan salmonella typhi dari hasil mikroenkapsulasi minyak atsiri Rogo (*Premna serratifolia* Linn). *Hydrogen J. Kependidikan Kim.* **2019**, *7*, 73–81. [CrossRef]
33. Singh, C.; Anand, S.K.; Tiwari, K.N.; Mishra, S.K.; Kakkar, P. Phytochemical profiling and cytotoxic evaluation of *Premna serratifolia* L. against human liver cancer cell line. *3 Biotech* **2021**, *11*, 115. [CrossRef]
34. Bhagavathy, S.; Mahendiran, C.; Kanchana, R. Identification of glucosyl transferase inhibitors from *Psidium guajava* against *Streptococcus mutans* in dental caries. *J. Tradit. Complement. Med.* **2019**, *9*, 124–137. [CrossRef]
35. Zhu, X.; Ouyang, W.; Lan, Y.; Xiao, H.; Tang, L.; Liu, G.; Cao, Y. Anti-hyperglycemic and liver protective effects of flavonoids from *Psidium guajava* L. (guava) leaf in diabetic mice. *Food Biosci.* **2020**, *35*, 100574. [CrossRef]
36. Rajput, R.; Kumar, K. Protective effect of ethanolic extract of guava leaves (*Psidium guajava* L.) in alloxan-induced diabetic mice. *Mater. Today Proc.* **2021**, *47*, 437–439. [CrossRef]
37. Khedr, S.I.; El Hassan, M.M.; Hassan, A.A.; El-Feki, A.S.; Elkhodary, G.M.; El-Gerbed, M.S. *Psidium guajava* Linn leaf ethanolic extract: In vivo giardicidal potential with ultrastructural damage, anti-inflammatory and antioxidant effects. *Saudi J. Biol. Sci.* **2021**, *28*, 427–439. [CrossRef]
38. Zhang, X.; Wang, J.; Zhu, H.; Wang, J.; Zhang, H. Chemical composition, antibacterial, antioxidant and enzyme inhibitory activities of the essential oil from leaves of *Psidium guajava* L. *Chem. Biodivers.* **2022**, *19*, e202100951. [CrossRef]
39. Koriem, K.M.M.; Arbid, M.S.; Saleh, H.N. Antidiarrheal and protein conservative activities of *Psidium guajava* in diarrheal rats. *J. Integr. Med.* **2019**, *17*, 57–65. [CrossRef] [PubMed]
40. Hirudkar, J.R.; Parmar, K.M.; Prasad, R.S.; Sinha, S.K.; Lomte, A.D.; Itankar, P.R.; Prasad, S.K. The antidiarrhoeal evaluation of *Psidium guajava* L. against enteropathogenic *Escherichia coli* induced infectious diarrhoea. *J. Ethnopharmacol.* **2020**, *251*, 112561. [CrossRef]
41. Huang, J.; Li, C.; Ma, J.; Xu, K.; Chen, X.; Jiang, J.; Zhang, D. Chemical constituents of *Psidium guajava* leaves and their antibacterial activity. *Phytochemistry* **2021**, *186*, 112746. [CrossRef]
42. Ryu, B.; Cho, H.M.; Zhang, M.; Lee, B.W.; Doan, T.P.; Park, E.J.; Oh, W.K. Meroterpenoids from the leaves of *Psidium guajava* (guava) cultivated in Korea using MS/MS-based molecular networking. *Phytochemistry* **2021**, *186*, 112723. [CrossRef]
43. Zhu, X.; Ouyang, W.; Pan, C.; Gao, Z.; Han, Y.; Song, M.; Cao, Y. Identification of a new benzophenone from *Psidium guajava* L. leaves and its antineoplastic effects on human colon cancer cells. *Food Funct.* **2019**, *10*, 4189–4198. [CrossRef]
44. Gea, S.J.B.P.; Juwitaningsih, T.; Riris, I.D.; Simorangkir, M.; Roza, D. Phytochemical screening and antibacterial activity, antilarvacides and toxicity test of acetone extract pulutan leave (*Urena lobata*). *J. Med. Vet.* **2021**, *15*, 56–63.
45. Rajagopal, P.L.; Linsha, K.T.; Sreejith, K.R.; Kumar, P.S.; Arthi, I.; Rahul, K.; Aneeshia, S. Anti-Arthritic activity of the leaves of *Urena lobata* Linn. *Int. J. Res. Rev.* **2019**, *6*, 86–89.
46. Purnomo, Y.; Tilaqza, A. Analgesic and anti-inflammatory activities of *Urena lobata* L. leaf extracts. *Indones. J. Pharm.* **2022**, *33*, 566–574. [CrossRef]

47. Purnomo, Y.; Soeatmadji, D.W.; Sumitro, S.B.; Widodo, M.A. Anti-diabetic potential of *Urena lobata* leaf extract through inhibition of dipeptidyl peptidase IV activity. *Asian Pac. J. Trop. Biomed.* **2015**, *5*, 645–649. [CrossRef]
48. Ajayi, G.O.; Olorunrinu, T.J.; Shittu, M.A. Elucidation of bioactive compounds in hydro alcohol extract of *Phyllanthus amarus* Schum. and Thonn. leaf using GC-MS analysis. *J. Sci. Innov. Res.* **2020**, *9*, 40–47. [CrossRef]
49. Rahman, A.; Shanta, Z.S.; Rashid, M.A.; Parvin, T.; Afrin, S.; Khatun, M.K.; Sattar, M.A. In vitro antibacterial properties of essential oil and organic extracts of *Premna integrifolia* Linn. *Arab. J. Chem.* **2016**, *9*, S475–S479. [CrossRef]
50. Albadawi, D.A.; Mothana, R.A.; Khaled, J.M.; Ashour, A.E.; Kumar, A.; Ahmad, S.F.; Almusayeib, N.M. Antimicrobial, anticancer, and antioxidant compounds from *Premna resinosa* growing in Saudi Arabia. *Pharm. Biol.* **2017**, *55*, 1759–1766. [CrossRef]
51. Ugbogu, E.A.; Emmanuel, O.; Uche, M.E.; Dike, E.D.; Okoro, B.C.; Ibe, C.; Ugbogu, O.C. The ethnobotanical, phytochemistry and pharmacological activities of *Psidium guajava* L. *Arab. J. Chem.* **2022**, *15*, 103759. [CrossRef]
52. Yahaya, A.; Ali, M.; EL-Hassan, F.I.; Jido, B.A. Antibacterial activity of Guava (*Psidium guajava* L.) extracts on *S. aureus* isolated from patients with urinary tract infections attending a Tertiary-Care Hospital. *Sci. World J.* **2019**, *14*, 47–51.
53. Quan, P.M.; Van, T.T.H.; Phuong, D.L.; Ich, C.T.; Long, P.Q.; Minh, P.T.H. Study on the chemical constituents of *Urena lobata* growing in Viet Nam. *Vietnam J. Sci. Technol.* **2019**, *57*, 162–169.
54. Keke, C.O.; Nsofor, W.N.; Kumabia, F.K.R.; Iloabuchi, G.C.; Ejiofor, J.C.; Osuagwu, O.L. GCMS and FTIR analysis of ethanol and methanol leave extract of *Urena lobata* (Caesar weed) for bioactive phytochemical constituents. *J. Drug Deliv. Ther.* **2023**, *13*, 99–115. [CrossRef]
55. Garuba, T.; Katrodiya, N.; Patel, N.; Patel, S.; Rajani, D.P.; Chettiar, S.S.; Krishnamurthy, R. Antibacterial activity of *Urena lobata* against uropathogens. *Niger. J. Nat. Prod. Med.* **2021**, *25*, 43–46. [CrossRef]
56. Azmir, J.; Zaidul, I.S.M.; Rahman, M.M.; Sharif, K.M.; Mohamed, A.; Sahena, F.; Jahurul, M.H.A.; Ghafoor, K.; Norulaini, N.A.N.; Omar, A.K.M. Techniques for extraction of bioactive compounds from plant materials: A review. *J. Food Engin.* **2013**, *117*, 426–436. [CrossRef]
57. Timotius, K.H.; Simamora, A.; Santoso, A.W. Chemical characteristics and In vitro antidiabetic and antioxidant activities of *Premna serratifolia* L. leaf infusion and decoction. *Pharmacogn. J.* **2018**, *10*, 1114–1118. [CrossRef]