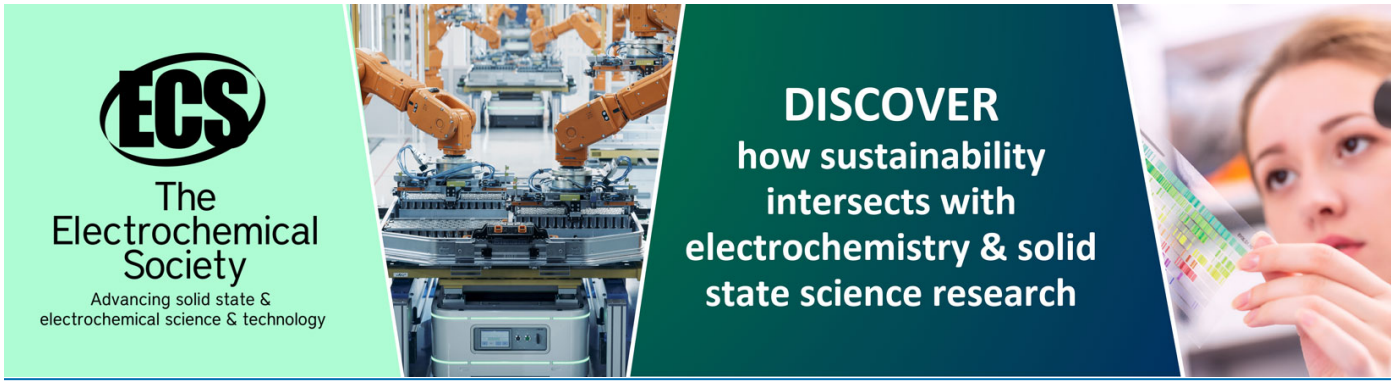
Ethnobotanical study of medicinal plants used for treating urinary tract problems in eastern Indonesia



Ethnobotanical study of medicinal plants used for treating urinary tract problems in eastern Indonesia

U Nisa[1*], P R W Astana[1], A Triyono[1], D Ardiyanto[1], U Fitriani[1], Z Zulkarnain[1], F Novianto[1] and W D M Jannah[2]

[1] Medicinal Plants and Traditional Medicine Research and Development Center, Jalan Raya Lawu number 11, Tawangmangu, Central Java, Indonesia
[2] Magelang Institute Health Research and Development Center, Kapling Jayan Borobudur, Magelang, Central Java, Indonesia

Corresponding author: redfa01@gmail.com

Abstract. Indonesia is one of the wealthiest countries in biological resources that have potential as medicinal plants. Medicinal plants can be an alternative in treating diseases such as urinary tract problems by the people of eastern Indonesia. The study aims to evaluate the use of medicinal plants for various urinary tract problems in east Indonesia, including their efficacy and safety based on the literature review. This research was conducted by interview method and field survey. The data were collected from traditional health practitioners in eastern Indonesia. Data were analyzed using Frequency of Citation (FC) and the Use value (UV). The results showed a total of 222 plants species belonging to 78 families were identified for treating urinary tract problems in east Indonesia. The most prevalent of these was the *Euphorbiaceae* family. The species which had the highest value were *Orthosiphon aristatus* (FC 12.52%, UV 0.31), *Sericocalyx crispus* (FC 7.80%; UV 0.19), *Phyllanthus niruri* (FC 6.35%; UV 0.16) were the vast majority commonly used plant species in the treatment of urinary tract problems. The most common parts used were leaves (44.87%) and herbs (10.66%). The ethnomedicinal flora in east Indonesia is quite diverse for treating urinary tract problems.

1. Introduction

Indonesia is one of the wealthiest countries in biological resources that have potential as medicinal plants. Medicinal plants have an important role in Indonesian society. They have used the use medicinal plants for a long time ago. Interestingly, medicinal plant research, mainly phytomedicines, has increased worldwide. It is especially seen in developed countries such as Indonesia [1]. The knowledge of medicinal plants had been passed down from generation to generation for each ethnicity [2]. The concept of local knowledge empirically based drug discovery has been around for a long time. While in some cases, the direct relationship between traditional local use of plants and modern medicine is complex [3].

East Indonesia region has special geographical conditions compared to other areas. Most of these areas are remote areas. Inhabitants of remote areas have a lower interest in health care facilities compared to urban areas. They prefer to use medicinal plants due to their easy availability as compared to chemical pharmaceuticals. Of course, this condition is greatly influenced by geographic access such as travel time and distances [4,5]. Hence, the plants are highly valued as sources of medicine by remote area communities [6].

Most of the world's population uses plants remedies for its primary health care. Because of its reliability, less toxicity, eco-friendly and straightforward [7]. The presence of various bioactive components of medicinal plants is considered to relate to pharmacological activities, which have essential effects from treating mild to severe diseases [8]. For example, urolithiasis is a significant health problem in many countries. Indonesia has a high incidence of urolithiasis [7]. Urolithiasis is one urinary tract problem that is commonly complained about by communities. The risk factor of urolithiasis consists of genetic factors, metabolic disturbances (excess oxalate synthesis), food, and environmental factors [9]. Several symptoms of urolithiasis are painful, requiring hospitalization and reducing the quality of life, leading to a decline in the socioeconomic community [10].

Documentation about medicinal plants plays a significant role in discovering a large variety of medicinal plants. In addition, the primary data of medicinal plants in Indonesia is still rare, especially information about the types of medicinal plants. Hence, Ethnobotanical research has been used to explore local knowledge of medicinal plants as part of each ethnicity's local wisdom, which can then be developed into new therapeutic resources. This study is also known as Research Medicinal Plants and Herbs (RISTOJA). This research was carried out for three years. The study aims to evaluate the use of medicinal plants for treating urinary problems in east Indonesia, including their efficacy and safety based on a literature review.

2. Methods

2.1. Description of the study area

The study area extended from West Nusa Tenggara province and Papua province, including Sulawesi and Maluku islands. West Nusa Tenggara lies between latitudes 8^{o} 10' and 9^{o} 5' (North-South Longitude), 115^{o} 46' and 119^{o} 5' (West – East Longitude). On the other hand, Papua province lies at 4° 16' S 138° 4' E. The climate of West Papua and Papua provinces is tropical, with rainfall varying in each region. Maluku islands which are greatly influenced by the presence of vast marine have a tropical monsoon climate. West Nusa Tenggara, East Nusa Tenggara, Sulawesi, and Maluku island were Wallace regions, meaning that it has a mix of both Indomalayan and Australasian species[11]. Wallace region is a biogeographic region between Asiatic and Australian flora and faunas showing a high degree of endemism organism [12]. The Wallace Line is an imaginary line that stretches from the Makassar Strait to the Sulawesi Sea to distinguish biogeographically between East and West [13].

2.2. Ethnopharmacology survey

The study was conducted in 2012, 2015, and 2017, located in all regions of Eastern Indonesia, including several provinces such as West Nusa Tenggara, East Nusa Tenggara, South Sulawesi, and Southeast Asia Sulawesi, North Sulawesi, Central Sulawesi, Maluku, North Maluku, Papua, and West Papua. An ethnomedicinal survey questionnaire-based descriptive study was used. Areas visited included determining informants using the purposive sampling method based on information from traditional community leaders or the local District Health Office. The selected informants were well known in the community due to their long practice of providing services related to conventional health care. The study was a face-to-face questionnaire.

The data were obtained by interview, field survey, and specimen collection. The interview was conducted according to the informants' local language, and the plant names were listed using scientific names based on the reference book. A semi-structured questionnaire was made to obtain demographic data, medicinal plant species to treat urinary tract problems, plant parts used, and methods used in the remedies.

The study was conducted following the requirements of the declarations of Helsinki, and written informed consent was obtained from the participants. Ethical clearance was accepted by the Ethics Commission of the National Institute of Health Research and Development, Ministry of Health.

2.3. Identification of medicinal plant species

Identification of plant specimens was carried out by a taxonomists team from several universities and the Indonesian Institute of Sciences, then stored in the Herbarium Tawangmanguensis, Karanganyar, Central Java.

2.4. Data analysis

Several plants were be selected. These plants, which were not medicinal plants and unidentified, were excluded. The informant's characteristics and medicinal plants data were presented descriptively. The quantitative analysis determined how essential and reliable these plants are for treating urinary tract problems. The Frequency of Citation (FC), Used Value (UV), Choice Value (CV), Family Use Value (FUV), and Informants Consensus Factor (IFC) were calculated by using the formula as described below:

2.4.1. The frequency of citation. It was calculated by using the following formula

$$FC = Ns \times 100$$

Ns as several times a species was mentioned by traditional healers/a total number of all species were mentioned × 100 [14]

2.4.2. Used value (UV). It was used to prove the relative importance of species known locally, and it can be calculated the following equation:

$$UVs = \frac{\Sigma U}{N}$$

The UV was the use-value of a species; U was the number of citations per species; N was the number of informants [14,15]

2.4.3. Family use value. It was used to obtain the number of informants employing certain species in a particular family. The following equation calculated it:

$$FUV = \frac{\Sigma UVs}{Ns}$$

High values for FUV and UVs indicate that taxa were frequently used as medicine. Where UVs were use-values for all the species within a given family. Ns = total number of species within a given family [15]

2.4.4. Informants consensus factor. It was a valuable assessment tool to evaluate the homogeneity information about medicinal plants to treat urinary problems. Nur is the number of use citations for treating urinary problems, and Nt is the number of taxa used to treat urinary tract problems [16].

$$IFC = \frac{Nur - Nt}{Nur - 1}$$

2.4.5. The choice value. It was used to appraise medicinal plant species to treat urinary tract problems. The CV was calculated by the following formula[14]:

$$CVs = \frac{Pcs}{Sc} \times 100$$

Pcs was the percentage of cited plant species for treating urinary tract problems by informants. Sc was the total number of species mentioned for treating urinary tract problems by all informants.

2.5. Study of literature

A literature study on eight of the highest UV plants systematically searched the scientific literature using Pubmed, Scopus, and Google Scholar electronic searching machines was published before August 2021.

3. Results and discussion

3.1. The characteristic of traditional practitioners of informants

The study involved 585 informants of 10 provinces in Eastern Indonesia which is consist of West Nusa Tenggara, East Nusa Tenggara, South Sulawesi, Southeast Sulawesi, North Sulawesi, Central Sulawesi, Maluku, North Maluku, Papua and West Papua. Because several informants were excluded, a total of 188 informants had knowledge of traditional medicine for treating urinary problems. We selected the partitioners who had plenty of patients in the community and had long practice providing services related to traditional health care. All informants were asked to give information about medicinal plant(s) used to treat urinary tract problems and parts of the plants used such as leaves roots, flowers, stems, and seeds. Half of the informants were 41–60 years old. There were only 7.9% of traditional practitioners from the younger group. This result is similar to other studies showing a gap between younger and older traditional practitioners [17,18].

Nearly half of informants had elementary and Junior High School education, followed by uneducated or incomplete elementary. Meanwhile, we know that literation competency is related to education. In addition, the majority of the people in rural areas are also illiterate[5]. Hence, the loss of medicinal plant knowledge has appeared in several countries [19]. Most informants learned about medicinal plants from family members (57%), followed by experiences (17.4%). The previous study revealed that knowledge of medicinal plants had been orally passed down from family members [19]. Another study had revealed 77% gained knowledge through observing their family members [14]. The threat of loss of acquired knowledge from generation to generation due to transmission between parents and younger generations is not always guaranteed [20,21]. The characteristic of traditional practitioners of informants is listed in Table 1 below.

Table 1. The characteristic of traditional practitioners of informants

Characteristic	Number of Informant	
	Frequency	Percentage (%)
Age groups		
≤ 40 yr	46	7.9
41-60 yr	297	50.8
≥ 60 yr	242	41.4
Education		
Uneducated/incomplete elementary	177	30.3
Elementary-Junior High School	282	48.2
Senior High School	104	17.8
Graduate	22	3.8
Source of knowledge (the answer can be more 1)		
Family member	478	57.0
Experience	146	17.4
Friend	61	7.3
Education	63	7.5
Others	90	10.7

3.2. Medicinal plants used for treating urinary tract problems

This study showed 222 species from 77 families utilized by traditional practitioners to treat urinary tract problems. All of the Latin scientific names of medicinal plants have been verified with www.theplantlist.org. The Use Value (UV) was calculated based on the informants' citations to assess the relative importance of reported medicinal plants. Its value ranged from 0.005 to 0.311 and is presented in Table 2. It also mentioned part of use, families, choice-value (CV), and Frequency of citation (FC). This study characterized that *Orthosiphon aristatus* (Bl.) Miq has the higher use value

(UV=0.311), Followed by *Sericocalyx crispus* (UV=0.194), *Phyllanthus niruri* (UV=0.158), and *Imperata cylindrica* (UV=0.068). There were 151 species of plants cited the least (UV=0.005 each).

Table 2. The medicinal plants used for treating urinary tract problems, the plant parts used, family, use values (UV), choice-value (CV), and Frequency of citation (FC)

Scientific names	parts	Family	FC (%)	UV	CV
Abelmoschus esculentus (L.) Moench		Malvaceae	0.181	0.005	0.001
Abelmoschus manihot (L.) Medik.	leaf, herb	Malvaceae	0.907	0.023	0.005
Abrus precatorius L.	herb	Leguminosae	0.181	0.005	0.001
Acalypha indica L.	herb, root, other	Euphorbiaceae	1.452	0.036	0.008
Acanthus ilicifolius L.	leaf	Acanthaceae	0.181	0.005	0.001
Acorus calamus L.		Acoraceae	0.181	0.005	0.001
Adenanthera pavonina L.		Leguminosae	0.181	0.005	0.001
Ageratum conyzoides L.	herb	Compositae	0.181	0.005	0.001
Allium cepa L.	tuber	Amaryllidaceae	0.363	0.009	0.002
Allium sativum L.	rhizoma	Amaryllidaceae	0.181	0.005	0.001
Allophyllus sp. Cf	root	Sapindaceae	0.181	0.005	0.001
Aloe vera (L.) Burm.f.	leaf	Asparagaceae	0.363	0.009	0.002
Alpinia galanga (L.) Willd.	rimpang	Zingiberaceae	0.726	0.018	0.004
Alstonia macrophylla Wall. ex G.Don	bark	Apocynaceae	0.181	0.005	0.001
Alstonia scholaris (L.) R. Br.	bark, stem	Apocynaceae	1.270	0.032	0.007
Amaranthus spinosus L.	leaf	Amaranthaceae	0.181	0.005	0.001
Amomum compactum Soland. Ex Malon		Zingiberaceae	0.181	0.005	0.001
Amomum sp.	leaf	Zingiberaceae	0.181	0.005	0.001
Amphineuron terminans (J. Sm.) Holttum		Thelypteridaceae	0.181	0.005	0.001
Andrographis paniculata (Burm.f.) Nees	leaf,other	Acanthaceae	0.726	0.018	0.004
Annona muricata L.	leaf	Annonaceae	0.726	0.018	0.004
Annona squamosa L.	leaf	Annonaceae	0.181	0.005	0.001
Anredera cordifolia (Ten.) Steenis	leaf	Basellaceae	0.181	0.005	0.001
Antiaris toxicaria Lesch.	bark	Moraceae	0.181	0.005	0.001
Arcangelisia flava (L.) Merr.	root	Menispermaceae	0.181	0.005	0.001
Archidendron clypearia (Jack) I.C.Nielsen		Leguminosae	0.181	0.005	0.001
Ardisia humilis Vahl	bark	Primulaceae	0.181	0.005	0.001
Areca catechu L.	root, fruit, pulp	Arecaceae	0.544	0.014	0.003
Arenga pinnata (Wurmb) Merr.	root	Arecaceae	0.726	0.018	0.004
Artocarpus altilis (Park.) Fosberg	leaf, bark	Moraceae	0.907	0.023	0.005
Asparagus sp. Cf	umbi	Asparagaceae	0.181	0.005	0.001
Averrhoa bilimbi L.	leaf	Oxalidaceae	0.363	0.009	0.002
Azadirachta indica A.Juss.		Meliaceae	0.363	0.009	0.002
Basella alba L.	stem	Basellaceae	0.181	0.005	0.001
Blumea balsamifera (L.) DC.	leaf	Compositae	0.726	0.018	0.004
Breynia sp. Cf	stem	Phyllanthaceae	0.181	0.005	0.001
Brucea javanica (L.) Merr.	leaf	Simaroubaceae.	0.181	0.005	0.001
Bryophyllum pinnatum (Lam.) Oken	leaf	Crassulaceae	0.181	0.005	0.001
Bulbophyllum sp.	fruit	Orchidaceae	0.181	0.005	0.001
Caesalpinia bonduc (L.) Roxb.	root	Leguminosae	0.181	0.005	0.001
Calamus sp. Cf	leaf	Arecaceae	0.181	0.005	0.001
Callicarpa longifolia Lam.	leaf	Lamiaceae	0.181	0.005	0.001
Calotropis gigantea (L.) W.T. Aiton	leaf	Apocynaceae	0.181	0.005	0.001
Carica papaya L.	leaf, root	caricaceae	0.363	0.009	0.002
Cassytha filiformis L.	herb	Lauraceae	0.181	0.005	0.001
Catharanthus roseus (L.) G.Don	leaf, root, tuber	Apocynaceae	1.089	0.027	0.006
Centella asiatica (L.) Urb.	leaf, stem, root, herb, other	Apiaceae	1.815	0.045	0.010
Centrosema pubescens Benth.	stem	Leguminosae	0.181	0.005	0.001
Cinnamomum burmanni (Nees & T.Nees) Blume	bark	Lauraceae	0.181	0.005	0.001
Citrus aurantiifolia (Christm.) Swingle	fruit	Rutaceae	0.363	0.009	0.002
Citrus japonica Thunb.	fruit	Rutaceae	0.181	0.005	0.001
Cleome rutidosperma DC.	herb	Cleomaceae	0.181	0.005	0.001
Cleome viscosa L.	herb	Cleomaceae	0.181	0.005	0.001
Clerodendrum cf calamitosum	leaf	Lamiaceae	0.181	0.005	0.001
Clerodendrum chinense (Osbeck) Mabb.	leaf	Lamiaceae	0.181	0.005	0.001
Clerodendrum japonicum (Thunb.) Sweet	leaf	Lamiaceae	0.181	0.005	0.001
Coccinia grandis (L.) Voigt	root	Cucurbitaceae	0.181	0.005	0.001
Cocos nucifera L.	pulp, other	Arecaceae	0.907	0.023	0.005
Codiaeum variegatum (L.) Rumph. ex A.Juss.	root	Euphorbiaceae	0.181	0.005	0.001
Cordia Sp. cf	stem	Boraginaceae	0.181	0.005	0.001

Crescentia cujete L.	leaf	Bignoniaceae	0.181	0.005	0.001
Crinum asiaticum L.	leaf	Amaryllidaceae	0.363	0.009	0.002
Crotalaria pallida Aiton	leaf	Leguminosae	0.181	0.005	0.001
Croton sp.	bark	Euphorbiaceae	0.181	0.005	0.001
Cucurbita moschata Duch.	leaf	Cucurbitaceae	0.181	0.005	0.001
Curcuma longa L.	rhizome	Zingiberaceae	1.815	0.045	0.010
Curcuma sp. Cf	rhizome	Zingiberaceae	0.181	0.005	0.001
Curcuma zanthorrhiza Roxb.	rhizome, leaf	Zingiberaceae	1.270	0.032	0.007
Curcuma zedoaria (Christm.) Roscoe	rhizome	Zingiberaceae	0.363	0.009	0.002
Cymbopogon citratus (DC.) Stapf	herb	Poaceae	0.181	0.005	0.001
Cymbopogon nardus (L.) Rendle	herb, bark, root, other	Poaceae	0.726	0.018	0.004
Cyrtandra longifolia (Wawra) Hillebr. ex C.B.Clarke	herb	Gesneriaceae	0.181	0.005	0.001
Datura metel L.		Solanaceae	0.181	0.005	0.001
Dendrophthoe pentandra (L.) Miq.	leaf	Loranthaceae	0.363	0.009	0.002
Dendrophthoe sp.	leaf	Loranthaceae	0.181	0.005	0.001
Desmodium gangeticum (L.) DC.	leaf	Leguminosae	0.181	0.005	0.001
Dioscorea smilacifolia De Wild. & T.Durand	root	Dioscoreaceae	0.181	0.005	0.001
Dischidia nummulariaÂ R.Br.	fruit	Apocynaceae	0.181	0.005	0.001
Dracaena angustifolia (Medik.) Roxb.	bark	Asparagaceae	0.363	0.009	0.002
Durio zibethinus L.	bark	Malvaceae	0.181	0.005	0.001
Eclipta prostrata (L.) L.	leaf	Compositae	0.181	0.005	0.001
Elephantopus mollis Kunth	leaf	Compositae	0.181	0.005	0.001
Elephantopus scaber L.	leaf	Compositae	0.181	0.005	0.001
Erythrina subumbrans (Hassk.) Merr.	bark	Leguminosae	0.181	0.005	0.001
Euphorbia glyptosperma Engelm.	herb	Euphorbiaceae	0.181	0.005	0.001
Euphorbia heterophylla L.	other	Euphorbiaceae	0.181	0.005	0.001
Euphorbia hirta L.	leaf,stem, root, herb,other	Euphorbiaceae	2.541	0.063	0.014
Euphorbia pulcherrima Willd. ex Klotzsch	leaf	Euphorbiaceae	0.181	0.005	0.001
Fatsia japonica (Thunb.) Decne. & Planch.	bark	Araliaceae	0.181	0.005	0.001
Fibraurea tinctoria Lour.	bark	Menispermaceae	0.181	0.005	0.001
Ficus altissima Blume	bark	Moraceae	0.181	0.005	0.001
Ficus racemosa L.	bark	Moraceae	0.181	0.005	0.001
Ficus septica Burm.f.	bark	Moraceae	0.544	0.014	0.003
Ficus variegata Bl.	bark	Moraceae	0.363	0.009	0.002
Flacourtia rukam Zoll. & Moritzi		Salicaceae	0.181	0.005	0.001
Flagellaria indica L.	root	Flagellariaceae	0.181	0.005	0.001
Floscopa scandens Lour.	leaf	Commelinaceae	0.181	0.005	0.001
Garuga floribunda Decne.	leaf	Burseraceae	0.181	0.005	0.001
Gnetum gnemon L.	leaf	Gnetaceae	0.181	0.005	0.001
Gossypium hirsutum L.	leaf	Malvaceae	0.363	0.009	0.002
Graptophyllum pictum (L.) Griff.	leaf	Acanthaceae	0.181	0.005	0.001
Gynura procumbens (Lour.) Merr.	leaf	Compositae	0.181	0.005	0.001
Hibiscus rosa-sinensis L.	leaf	Malvaceae	0.181	0.005	0.001
Hibiscus tiliaceus L.	leaf	Malvaceae	0.544	0.014	0.003
Hyptis capitata Jacq.	leaf	Lamiaceae	0.181	0.005	0.001
Imperata cylindrica (L.) Raeusch.	root,herb,other	Poaceae	2.722	0.068	0.014
Intsia sp.	leaf	Leguminosae	0.181	0.005	0.001
Ipomoea mauritiana Jacq.	root	Convolvulaceae	0.181	0.005	0.001
Ipomoea pes-caprae (L.) R. Br.	leaf	Convolvulaceae	0.181	0.005	0.001
Ipomoea sp. Cf	root	Convolvulaceae	0.181	0.005	0.001
Ixora chinensis Lam.	leaf	Rubiaceae	0.181	0.005	0.001
Jasminum sambac (L.) Aiton	leaf, flower	Oleaceae	0.363	0.009	0.002
Jatropha curcas L.	root	Euphorbiaceae	0.544	0.014	0.003
Jatropha gossypiifolia L.	root	Euphorbiaceae	0.181	0.005	0.001
Justicia gendarussa Burm. f.	leaf, herb	Acanthaceae	0.363	0.009	0.002
Kaempferia galanga L.	rhizoma	Zingiberaceae	0.181	0.005	0.001
Kleinhovia hospita L.	leaf,root, bark	Malvaceae	0.726	0.018	0.004
Knema sp.	bark	Myristicaceae	0.181	0.005	0.001
Lannea coromandelica (Houtt.) Merr.		Anacardiaceae	0.181	0.005	0.001
Lansium parasiticum (Osbeck) K.C.Sahni & Bennet	bark	Meliaceae	0.181	0.005	0.001
Laportea interrupta (L.) Chew	other	Urticaceae	0.181	0.005	0.001
Laportea peduncularis (Wedd.) Chew	leaf	Urticaceae	0.181	0.005	0.001
Lasia spinosa (L.) Thwaites	fruit	Araceae	0.181	0.005	0.001
Leea indica (Burm.f.) Merr.	leaf	Vitaceae	0.181	0.005	0.001
Loranthus sp.1	root	Loranthaceae	0.544	0.014	0.003
Lygodium flexuosum (L.) Sw.	root	Schizaeaceae	0.181	0.005	0.001

Lygodium microphyllum (Cav.) R. Br.	leaf	Schizaeaceae	0.181	0.005	0.001
Macaranga subpeltata K.Schum. & Lauterb.	root	Euphorbiaceae	0.181	0.005	0.001
Mallotus paniculatus (Lmk.) M.A.	leaf	Euphorbiaceae	0.363	0.009	0.002
Mallotus macrostachyus (Miq.) Müll. Arg.	leaf	Euphorbiaceae	0.181	0.005	0.001
Mallotus mollissimus (Geiseler) Airy Shaw	leaf	Euphorbiaceae	0.181	0.005	0.001
Mangifera indica L.	bark	Anacardiaceae	0.181	0.005	0.001
Melanolepis multiglandulosa (Reinw. ex Blume) Rchb. & Zoll.	leaf	Euphorbiaceae	0.181	0.005	0.001
Melanthera biflora (L.) Wild	leaf	Compositae	0.181	0.005	0.001
Merremia peltata (L.) Merr.	bark	Convolvulaceae	0.181	0.005	0.001
Merremia umbellata (L.) Hallier f.	leaf	Convolvulaceae	0.181	0.005	0.001
Microcos antidesmifolia (King) Burret	bark	Tiliaceae	0.181	0.005	0.001
Morinda citrifolia L.	leaf, bark, fruit	Moringaceae	0.907	0.023	0.005
Moringa oleifera Lam.	root,bark	Moringaceae	0.363	0.009	0.002
Musa sp.	stem	Musaceae	0.181	0.005	0.001
Myristica fragrans Houtt.	rind, fruit	Myristicaceae	0.726	0.018	0.004
Myrmecodia pendans Merr. & Perry	tuber	Rubiaceae	0.363	0.009	0.002
Myrmecodia tuberosa Jack	rind	Rubiaceae	0.181	0.005	0.001
Ocimum basilicum L.	leaf	Lamiaceae	0.181	0.005	0.001
Ocimum tenuiflorum L.	leaf	Lamiaceae	0.363	0.009	0.002
Opuntia sp. Cf	leaf	Cactaceae	0.181	0.005	0.001
Orthosiphon aristatus (Bl.) Miq.	leaf, stem, root, flower, fruit, herb, other	Lamiaceae	12.523	0.311	0.067
Pandanus tectorius Parkinson ex Du Roi	root	Pandanaceae	0.363	0.009	0.002
Passiflora foetida L.	leaf	Passifloraceae	0.363	0.009	0.002
Peperomia pellucida (L.) Kunth	herb	Piperaceae	0.181	0.005	0.001
Peristrophe bivalvis (L.) Merr.	herb	Acanthaceae	0.181	0.005	0.001
Persea americana Mill.	leaf	Lauraceae	0.726	0.018	0.004
Phaleria macrocarpa (Scheff.) Boerl.	pulp	Thymelaeaceae	0.181	0.005	0.001
Phyllanthus amarus Schumach. & Thonn.	herb, other	Phyllanthaceae	0.544	0.014	0.003
Phyllanthus niruri L.	leaf, stem, root, flower,fruit, seed, herb, other	Phyllanthaceae	6.352	0.158	0.034
Phyllanthus sp.	leaf	Phyllanthaceae	0.181	0.005	0.001
Phyllanthus urinaria L.	leaf, stem, root, other	Phyllanthaceae	1.089	0.027	0.006
Physalis angulata L.	leaf, fruit, herb	Solanaceae	0.907	0.023	0.005
Physalis minima L.	fruit, herb, other	Solanaceae	0.726	0.018	0.004
Phytolacca americana L.	root	Phytolaccaceae	0.181	0.005	0.001
Picria fel-terrae Lour.	herb	Linderniaceae	0.181	0.005	0.001
Piper betle L.	leaf	Piperaceae	0.544	0.014	0.003
Piper retrofractum Vahl		Piperaceae	0.181	0.005	0.001
Pisonia grandis R. Br.	bark	Nyctaginaceae	0.181	0.005	0.001
Plantago major L.	leaf, herb	Plantaginaceae	0.363	0.009	0.002
Plectranthus scutellarioides (L.) R.Br.	leaf	Lamiaceae	0.544	0.014	0.003
Pluchea indica (L.) Less.	leaf	Asteraceae	0.181	0.005	0.001
Pogostemon sp. Cf	leaf	Lamiaceae	0.181	0.005	0.001
Poikilospermum cordifolium (Barg.-Petr.) Merr.	bark	Urticaceae	0.181	0.005	0.001
Polygonum sp.	leaf, stem	Polygonaceae	0.363	0.009	0.002
Polyscias diversifolia (Blume) Lowry & G.M.Plunkett	leaf	Araliaceae	0.181	0.005	0.001
Polyscias fruticosa (L.) Harms	bark	Araliaceae	0.181	0.005	0.001
Pongamia pinnata (L.) Pierre	root	Fabaceae	0.181	0.005	0.001
Portulaca oleracea L.	other	Portulacaceae	0.181	0.005	0.001
Pseudolephantopus spicatus Rohr ex Gleason	root	Asteraceae	0.181	0.005	0.001
Psidium guajava L.	leaf	Myrtaceae	0.907	0.023	0.005
Pterocarpus indicus Willd.		Leguminosae	0.181	0.005	0.001
Pterocymbium javanicum R.Br.	bark	Sterculiaceae	0.181	0.005	0.001
Rhinacanthus nasutus (L.) Kurz	leaf	Acanthaceae	0.181	0.005	0.001
Ruellia tuberosa L.	leaf	Acanthaceae	0.181	0.005	0.001
Scaevola taccada (Gaertn.) Roxb.	leaf	Goodeniaceae	0.181	0.005	0.001
Scleria sumatrensis Retz.	leaf, other	Cyperaceae	0.363	0.009	0.002
Scurrula atropurpurea (Blume) Danser	leaf, stem	Loranthaceae	0.363	0.009	0.002
Scurrula ferruginea (Jack) Danser	leaf	Loranthaceae	0.363	0.009	0.002
Scurrula parasitica L.	stem	Loranthaceae	0.181	0.005	0.001
Senna multijuga (Rich.) H.S.Irwin & Barneby	root	Fabaceae	0.181	0.005	0.001
Senna sp. Cf	bark	Fabaceae	0.181	0.005	0.001

Sericocalyx crispus (L.) Bremek	leaf, stem, root, flower, herb, other	Malvaceae	7.804	0.194	0.042
Sida acuta Burm.f.	other	Malvaceae	0.181	0.005	0.001
Sida alnifolia var. Alnifolia	other	Malvaceae	0.181	0.005	0.001
Sida cordifolia L.	herb	Malvaceae	0.181	0.005	0.001
Solanum lycopersicum Lam.		Solanaceae	0.181	0.005	0.001
Solanum rudepannum Dunal		Solanaceae	0.181	0.005	0.001
Solanum torvum Sw.	leaf	Solanaceae	0.181	0.005	0.001
Sonchus arvensis L.	leaf	compositae	0.181	0.005	0.001
Spathoglottis plicata Blume	tuber	Orchidaceae	0.181	0.005	0.001
Spondias dulcis Parkinson	bark	Anacardiaceae	0.181	0.005	0.001
Stachytarpheta jamaicensis (L.) Vahl	leaf, other	Verbenaceae	0.363	0.009	0.002
Stephania hernandiifolia (Willd.) Walp.	leaf	Menispermaceae	0.181	0.005	0.001
Sterculia sp.	leaf, bark	Sterculiaceae	0.544	0.014	0.003
Strobilanthes crispa Blume.	herb	Acanthaceae	0.181	0.005	0.001
Symphytum officinale L.	leaf	Boraginaceae	0.181	0.005	0.001
Syzygium aromaticum (L.) Merr. & L.M.Perry	leaf, flower, other	Myrtaceae	0.726	0.018	0.004
Syzygium cumini (L.) Skeels	stem	Myrtaceae	0.181	0.005	0.001
Syzygium polyanthum (Wight) Walp.	leaf	Myrtaceae	0.181	0.005	0.001
Tabernaemontana arborea Rose ex J.D.Sm.		Apocynaceae	0.181	0.005	0.001
Talinum fruticosum (L.) Juss.	tuber, herb	Talinaceae	0.363	0.009	0.002
Terminalia catappa L.	bark	Combretaceae	0.181	0.005	0.001
Terminalia sericocarpa F.Muell.	root	Combretaceae	0.181	0.005	0.001
Thespesia populnea (L.) Sol. ex Corrêa	leaf	Malvaceae	0.181	0.005	0.001
Tinospora crispa (L.) Hook. f. & Thomson	stem	Menispermaceae	0.181	0.005	0.001
Tournefortia acutiflora M.Martens & Galeotti	leaf	Boraginaceae	0.181	0.005	0.001
Trevesia palmata (Roxb. ex Lindl.) Vis.	bark	Araliaceae	0.181	0.005	0.001
Tridax procumbens (L.) L.		Compositae	0.181	0.005	0.001
Tylophora indica (Burm. f.) Merr.	root	Apocynaceae	0.363	0.009	0.002
Urena lobata L.	leaf, rhizoma	Malvaceae	0.726	0.018	0.004
Vanda sp.	root	Orchidaceae	0.181	0.005	0.001
Vernonia amygdalina Delile	leaf	Compositae	0.363	0.009	0.002
Vitex cofassus Reinw. ex Bl.	leaf, root	Lamiaceae	0.363	0.009	0.002
Zea mays L.		Poaceae	0.181	0.005	0.001
Zingiber officinale Roscoe	rhizoma	Zingiberaceae	0.544	0.014	0.003
Zingiber zerumbet (L.) Roscoe ex Sm.	rhizoma	Zingiberaceae	0.363	0.009	0.002

The relative importance of plant species to treat particular diseases locally has been signified with the Use value (UV) [22,23]. The most cited plants might indicate informants' consciousness to use them as the leading choices for treating urinary tract problems[24]. Meanwhile, the least of use-value of certain species does not imply that it was less efficacy. It might be caused by ignorance of informants about related knowledge or inaccessibility of the plants[18].

There is only one Informant Consensus Factor (ICF) in this study. This factor indicates information's homogeneity. The plants are chosen randomly when this factor is close to 0. On the contrary, This factor is close to 1 when the data is frequently exchanged between informants[22,25,26]. The ICF was 0.60, and this factor was classified as moderate. Hence. It signifies an adequate exchange of information about medicinal plants for treating urinary tract problems between informants.

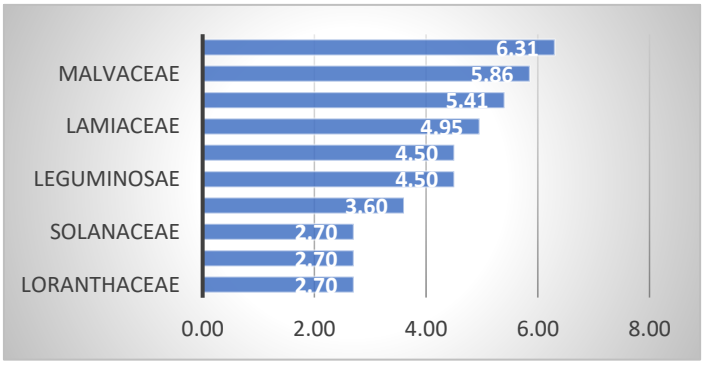


Figure 1. The highest number of Family Use Value (FUV)

The family having high FUV were Euphorbiaceae (FUV= 6.31), Malvaceae (FUV=5.86), and Compositae (5.41), as enlisted Figure 1. The relative importance of family to underline plant families that have more utilizes than randomly estimated can be revealed by the family use value (FUV)[18]. Based on the result, 14 species were employed as traditional medicine, including *Acalypha indica* L, *Codiaeum variegatum* (L.) Rumph. ex A.Juss, *Croton sp*, *Euphorbia glyptosperma* Engelm, *Euphorbia heterophylla* L, *Euphorbia* hirta L, *Euphorbia pulcherrima* Willd. ex Klotzsch, *Jatropha curcas* L, *Jatropha gossypiifolia* L, *Macaranga subpeltata* K.Schum. & Lauterb, *Mallotus paniculatus* (Lmk.) M.A, *Mallotus macrostachyus* (Miq.) Müll. Arg, *Mallotus mollissimus* (Geiseler) Airy Shaw, *Melanolepis multiglandulosa* (Reinw. ex Blume) Rchb. & Zoll. The Family Use Value (FUV) can help determine most species' favorable ecological conditions and adaptations [21].

As presented in Figure 2, The most used plants for treating urinary tract problems were leaves, followed by roots and herbs. The reason for leaves as the primary plant material for the preparation of traditional medicines is their easy availability both as ingredients and drug preparation. Furthermore, leaves are also the site of photosynthesis so that they might have a high content of metabolites [27].

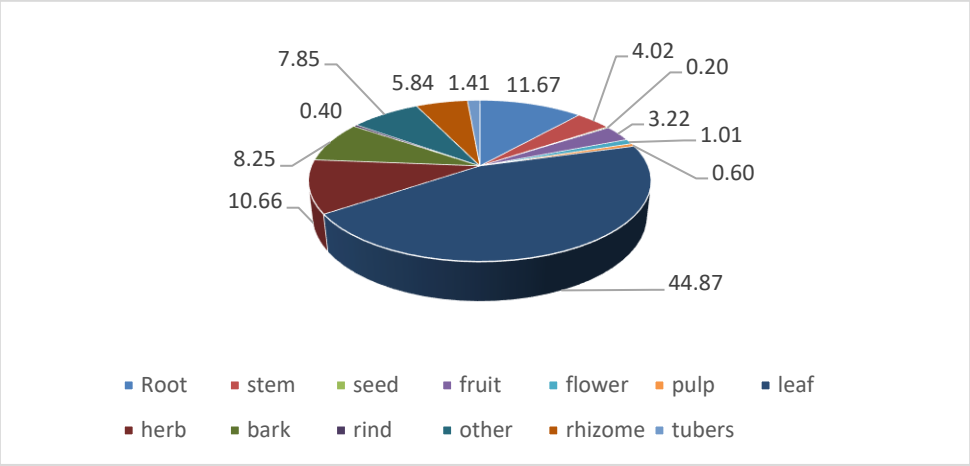


Figure 2. The proportion of medicinal plant part of used treating urinary problems

Table 3. The result of the literature study on the eight most important medicinal plants

Scientific names	Family	Reference
Orthosiphon aristatus (Bl.) Miq	Lamiaceae	Markedly reduced CaOx crystal formation led to anti-nephrolithiasis agent[28,29], mechanism of EEOS in the treatment of stone disease from the lipid molecular level[30].
Sericocalyx crispus (L.) Bremek	Malvaceae	The acute toxicity of *Sericocalyx crispus* orally administered to rats in 1, 2, and 5 g/kgbw was safe, and that no drug-related toxicity was detected[31]. Ethanol extract of Strobilanthes crispa (L) Blume) could dissolve kidney stones (calcium and oxalate), led to increasing in dissolving calcium and oxalate in urine in vivo[32].
Phyllanthus niruri L.	Phyllanthaceae	*Phyllanthus niruri's* extract can inhibit CaOx crystal aggregation and interferes with calculus growth in the early stage[33,34]. The antispasmodic and relaxant effects of *Phyllanthus* on contractile tissue[35,36]. No adverse acute or chronic toxic effects of P.niruri were reported[37,38]. *Phyllanthus* has bioactive compounds which can decrease diabetic nephropathy progression to chronic renal failure[39]. Administration of *Phyllanthus niruri* for three months can remove 3 mm of calculi in nephrolithiasis patients[40]. It can be used to normalize urinary calcium levels and decrease the recurrence of nephrolithiasis[41].
Imperata cylindrica (L.) Raeusch	Poaceae	Diuretic and anti-inflammatory effect[42,43]. Both prophylactic and curative effects in dissolving stones in vivo[29]. The ethanol extract of *Imperata cylindrica* has the effect of dissolving calcium kidney stones in vitro[44].
Euphorbia hirta L.	Euphorbiaceae	Low back pain[45], inhibiting the formation of struvite crystals[46] in vitro, significant antilithiatic potential against calcium oxalate kidney stones in vitro[47,48].
Centella asiatica (L.) Urb.	Apiaceae	Diuretic[49,50], anti-inflammatory[51], anti urolithiatic agent in study ethnopharmacologic[52].
Curcuma longa L.	Zingiberaceae	Potential nephroprotective agents[53] Dissolve kidney stone, diuretic[50].

Acalypha indica L.	Euphorbiaceae	Antibacterial activity[54], Urinary tract infections[55], diuretic[50].antioxidant as antiurolithiatic activity in vivo[56]

This study showed eight species of plants that had a high level of UV (Table 3). Their species have several benefits for treating urinary tract problems. Besides anti-urolithiasis agents, several of them can be employed to improve renal function. Aqueous-ethanolic extracts have diuretic activity in vivo in rats. Diuretics can also be prophylactic agents for urolithiasis due to their significant role in regulating kidney function and lightening the urinary risk factors for stone formation. Hence, *Orthosiphon aristatus* being commonly used for dissolving kidney stones. Several studies revealed its hypouricemic activity in rats leading to the formation of oxalate crystals [57]. Asian countries usually consumed Orthosiphon aristatus as a treatment for dysuria and eliminated kidney bladder[58]. *Phyllanthus niruri* is a medicinal plant that has the second-highest species use value after *Orthosiphone aristatus*. In addition, it belongs to the Euphorbiaceae family that was the highest Family Use Value (FUV). The *Phyllanthus niruri* had the highest efficacy in dissolving calculi ≤ 3 mm, located in the middle or upper calyx[59]. Moreover, it also has anti-inflammatory, anti-hyperuricemic, and diuretic properties. *Phyllanthus niruri* is beneficial for Patients with specific urinary metabolic changes such as hyperuricosuria and hyperoxaluria, which are typically involved in forming urinary calculi.[38]. The nephroprotective activity of *Phyllanthus niruri* has been investigated in Diabetic Nephropathy patients [39].

There were several instances where *Datura metel, Croton sp* was employed as part of urinary tract problems formulation, even though They were of poisonous plants in an ethnomedicinal study in Zimbabwe[60].

Orthosiphon aristatus and *Phyllanthus niruri* both have high UV so it can be concluded that both plants have been long known and used by informants in Eastern Indonesia. The literature showed several evaluations on the biological compound has been conducted on such plants.

4. Conclusion

Based on the result, *Orthosiphon aristatus* and *Phyllanthus niruri* are the most employed medicinal plants for treating urinary tract problems in eastern Indonesia. Their safety and efficacy have been proven by previous research. Hence, people far from health care facilities can adopt both plants as medication for treating urinary tract problems. *Datura metel* and *Croton Sp* are not suggested due to their toxic nature.

Acknowledgments

We are grateful to all researchers in RISTOJA for their kind information and share of data. We are also grateful that Medicinal Plant and Traditional Medicine Center has supported this study.

References

[1] Dutra R C, Campos M M, Santos A R S and Calixto J B 2016 *Pharmacol. Res.* **112** 4–29
[2] Mosaddegh M, Naghibi F, Moazzeni H, Pirani A and Esmaeili S 2012 *J. Ethnopharmacol.* **141** 80–95
[3] Heinrich M and Gibbons S 2001 *J. Pharm. Pharmacol.* **53** 425–32
[4] Chan L, Hart L G and Goodman D C 2006 *J. Rural Heal.* **22** 140–6
[5] Bibi T, Ahmad M, Bakhsh Tareen R, Mohammad Tareen N, Jabeen R, Rehman S U, Sultana S, Zafar M and Yaseen G 2014 *J. Ethnopharmacol.* **157** 79–89
[6] Balberona A N, Noveno J J, Angeles M G, Santos R I, Cachin E J and Cruz K G 2018 *Int. J. Agric. Technol.* **14** 145–59
[7] Kaleeswaran B, Ramadevi S, Murugesan R, Srigopalram S, Suman T and Balasubramanian T 2019 *J. Tradit. Complement. Med.* **9** 24–37
[8] Pratyush K, Misra C, James J, Dev L and Veettil A 2011 *Jpsr.Pharmainfo.in* **3** 1394–403
[9] Afkari R, Feizabadi M M, Ansari-Moghadam A, Safari T and Bokaeian M 2019 *Int. Braz J Urol* **45** 1249–59
[10] Kang H W, Seo S P, Kim W T, Kim Y J, Yun S J, Lee S C and Kim W J 2014 *J. Korean Med.*

Sci. **29** 1132–7
[11] Kusmana C and Hikmat A 2015 *J. Nat. Resour. Environ. Manag.* **5** 187–98
[12] Moss J S and Wilson E J M 1998 *Biogeographic implications of the Tertiary palaeogegraphic evolution of Sulawesi and Borneo* ed R Hall and D J Holloway (Leiden: Backhuys Publisher)
[13] van Welzen P C, Parnell J A N and Slik J W F 2011 *Biol. J. Linn. Soc.* **103** 531–45
[14] Jaradat N A, Zaid A N, Al-Ramahi R, Alqub M A, Hussein F, Hamdan Z, Mustafa M, Qneibi M and Ali I 2017 *BMC Complement. Altern. Med.* **17** 255
[15] Hoffman B and Gallaher T 2007 *Ethnobot. Res. Appl.* **5** 201–18
[16] Alzweiri M, Sarhan A Al, Mansi K, Hudaib M and Aburjai T 2011 *J. Ethnopharmacol.* **137** 27–35
[17] Dey A K, Rashid M O, Millat S and Rashid M 2014 *Int. J. Pharm. Sci. Invent.* **3** 1–7
[18] Mustofa I F, Rahmawati N and Saryanto S 2021 *J. Tumbuh. Obat Indones.* **14** 29–47
[19] Musa M S, Abdelrasool F E, Elsheikh E A, Ahmed L A M N, Mahmoud A L E and Yagi S M 2011 *J. Med. Plants Res.* **5** 4287–97
[20] Anyinam C 1995 *Soc. Sci. Med.* **40** 321–9
[21] Chaachouay N, Benkhnigue O, Fadli M, El Ibaoui H and Zidane L 2019 *Heliyon* **5** e02191
[22] Jaradat N A, Ayesh O I and Anderson C 2016 *J. Ethnopharmacol.* **182** 57–66
[23] Kusnafizal T, Azis A and Iswanto S 2020 *Indones. Hist. Stud.* **4** 186–95
[24] Adnan M, Ullah I, Tariq A, Murad W, Azizullah A, Khan A L and Ali N 2014 *J. Ethnobiol. Ethnomed.* **10** 1–16
[25] Ferrier J, Saciragic L, Trakić S, Chen E C H, Gendron R L, Cuerrier A, Balick M J, Redžić S, Alikadić E and Arnason J T 2015 *J. Ethnobiol. Ethnomed.* **11** 81
[26] Yaseen G, Ahmad M, Sultana S, Suleiman Alharrasi A, Hussain J, Zafar M and Shafiq-Ur-Rehman 2015 *J. Ethnopharmacol.* **163** 43–59
[27] Eddouks M, Ajebli M and Hebi M 2017 *J. Ethnopharmacol.* **198** 516–30
[28] Zhong Y S S, Yu C H H, Ying H Z Z, Wang Z Y Y and Cai H F F 2012 *J. Ethnopharmacol.* **144** 761–7
[29] Nisa U and Astana P R W 2018 *Bul. Penelit. Kesehat.* **46** 275–86
[30] Chao Y, Gao S, Li N, Zhao H, Qian Y, Zha H, Chen W and Dong X 2020 *Front. Pharmacol.* **11** 1299
[31] Nurraihana H and Norfarizan-Hanoon N A 2013 *Int. Food Res. J.* **20** 2045–56
[32] Dharma S, Aria M and Syukri E F 2014 *Scienta* **4** 34–7
[33] Narendra K, Swathi J, Sowjanya K M and Satya A K 2012 *J. Pharm. Res.* **5** 4681–91
[34] Sharma S, Sharma O, Meena B and Kumavat V 2017 *J. Res. Ayurvedic Sci.* **1** 117–24
[35] Freitas A M, Schor N and Boim M A 2002 *BJU Int.* **89** 829–34
[36] Nagal A and Singla R K 2013 *Indo Glob. J. Pharm. Sci.* **3** 6–14
[37] e Silva T C de L, Filho J V, de Amorim E L C, de Souza I A, de Albuquerque U P and de Araújo E C 2012 *Rev. Ciencias Farm. Basica e Apl.* **33** 205–10
[38] Pucci N D, Marchini G S, Mazzucchi E, Reis S T, Srougi M, Evazian D and Nahas W C 2018 *Int. Braz J Urol* **44** 758–64
[39] Giribabu N, Karim K, Kilari E K and Salleh N 2017 *J. Ethnopharmacol.* **205** 123–37
[40] Cealan A, Coman R T, Simon V, Andras I, Telecan T, Coman I and Crisan N 2019 *Med. Pharm. Reports* **92** 153–7
[41] Rodgers A L, Webber D, Ramsout R and Gohel M D I 2014 *Urolithiasis* **42** 221–5
[42] Listyawati S, Suratman, Listyawati S and Sutarno 2003 *Biofarmasi* **1** 7–12
[43] Zulkarnain Z, Wijayanti E, Fitriani U and Triyono A 2020 *Media Penelit. dan Pengemb. Kesehat.* **29** 329–40
[44] Lilyawati S A, Fitriani N and Prasetya F 2019 *Proceeding Mulawarman Pharm. Conf.* 135–8
[45] Desak M M, Madihah, Joko K, Fitri K and Johan I 2017 Biosaintifika *Biosaintifika* **9** 345–56
[46] Arts S, Nadu T, Arts S and Nadu T 2019 *J. Pharmacogn. Phytochem.* **8** 2145–51
[47] Kumari S and Gupta A K 2018 *Int. J. Pharm. Res.* **9** 23–6

[48] Kumar S and Arya A 2021 *Int. J. Pharm. Sci. Res.* **12** 991–4
[49] Rai M B 2003 *Our Nat.* **1** 42–8
[50] Sharma G and Lamichhane G 2017 *Pharma Innov. J.* **6** 8–12
[51] Siew Y Y, Zareisedehizadeh S, Seetoh W G, Neo S Y, Tan C H and Koh H L 2014 *J. Ethnopharmacol.* **155** 1450–66
[52] Khajuria A K and Bisht N 2017 *Int. J. Herb. Med.* **5** 10–3
[53] Peesa J P 2013 *Asian J. Pharm. Technol.* **3** 115–8
[54] Modilal M R D, Daisy P, Sheela Devi A, Bhuvaneswari V and Abarna K 2012 *J. Sci. Res. Pharm.* **1** 73–5
[55] Mollik M A H, Hossan M S H, Paul A K, Taufiq-Ur-Rahman M, Jahan R and Rahmatullah M 2010 *Ethnobot. Res. Appl.* **8** 195–218
[56] Sathya M, Kokilavani R, Teepa K S A and Balakrishnan A 2011 *Anc. Sci. Life* **31** 3–9
[57] European Medicines Agency 2021 *Assessment report on Orthosiphon aristatus (Blume) Miq. var. aristatus, folium* (EMA)
[58] Chai T T, Wong F C, Manan F A, Ooh K F and Ismail N I I 2014 *Tradit. Folk Herb. Med. Recent Res.* **2** 153–87
[59] Cealan A, Coman R-T, Simon V, Andras I, Telecan T, Coman I and Crisan N 2019 *Med. Pharm. reports* **92** 153—157
[60] Maroyi A 2012 *Ethnobot. Res. Appl.* **10** 45–57