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A Review of the Economic Botany of *Sesbania* (Leguminosae)

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Abstract

Sesbania is a genus in family Leguminosae. Among about 60 species of *Sesbania*, 22 species have reported economic uses in tropical and subtropical regions. This review provide information on the use of *Sesbania* species and their other economic importance. The knowledge of *Sesbania* uses may enhance food security, health security and environmental security in remoted areas.

Keywords Food, Traditional medicines, Traditional knowledge, Useful weeds

Introduction

Sesbania species provide many services. Due to the nitrogen fixing properties of bacteria in both root and stem nodules, they are widely cultivated for soil improvement as biofertilizer and they are used in agroforestry (Kalidurai & Kannaiyan, 1991). Moreover, *Sesbania* species have pharmacological properties; *Sesbania bispinosa*¹ is used as an anti-inflammatory (Boddawar et al. 2016), *S. grandiflora* has antidiabetic (Kumar et al., 2015) and anticancer activity (Roy et al., 2013), *S. rostrata* is a multipurpose medicinal plant in India where it is used to treat diuretic and emetic conditions and also fevers, headaches, anemia, bronchitis, inflammation, leprosy, gout, rheumatism, anxiolytic, it is anticonvulsive, and is also used as a hepatoprotective (Kadam et al., 2013). Apart from environmental and medicinal uses, species of *Sesbania* are also used as food for humans and animals, fuels, fiber, fish poison, and ornamentals (Gillett, 1963). More recently some species of *Sesbania* have become important in wastewater treatment due to their capacity to accumulate heavy metals (Eller & Brix, 2016). Information about these and a multitude of other uses of *Sesbania* are scattered in the literature. In this review, the economic importance and the traits of the *Sesbania* species that make them so useful, including the anatomy of stem fibers, chemical descriptions of compounds with medicinal properties, phytochemical processes that function in heavy metal accumulation are reviewed.

The genus *Sesbania* contains 60–85 species of herbs, shrubs, and trees. They are mostly distributed in tropical and sub-tropical regions with most (c. 30) species occurring in Africa and Madagascar, nine species in Asia and the Pacific region, 7–10 species in Australia, 13 species in the Americas, and five species that are widespread (Farruggia, 2009; Lewis et al., 2005). Species of *Sesbania* grow in regions with seasonally dry tropical climates and also in subtropical and warm temperate areas. Their habitats include wet areas at the margins of lakes and rivers, swamps and riverine forests and sometimes woodland, grasslands, and wooded grassland (Lewis et al., 2005). In

¹ Names of species are given without their author's names in the running text; author names for each name can be found in APPENDIX 1 which provides a list of *Sesbania* and other plant names mentioned in the text.

Thailand, where we have had extensive opportunities to observe and collect *Sesbania*, most species are weedy growing in wastelands and at roadsides or in wet ditches along roads and agricultural field. *Sesbania grandiflora* is different: it is cultivated in homegardens throughout the country.

For this review we searched all papers that mention “*Sesbania*” on Google Scholar (<https://scholar.google.dk/>). We also searched books and reports about useful plants in general. All these papers were searched for information about uses of any species of *Sesbania*. The information was divided into categories following the *Economic Botany Data Collection Standard* (Cook, 1995). We use this as our framework because it is accepted as a standard by the Biodiversity Information Standards (www.tdwg.org/standards), and it is commonly used among economic botanists and using it, therefore makes comparison with other studies in economic botany possible. The results are presented as running text, except for the categories *Human Food and Nutrition* and *Medicines*, where the information is presented in Tabular form due to the large amounts of data.

Uses of *Sesbania*

We found references to uses of *Sesbania* species in eight categories (Human food and nutrition, Animal food and nutrition, Poisons, Medicines, Environmental uses, Materials, Fuel, Social uses) of which the use for food and medicine were by far the most commonly mentioned.

1. Human food and nutrition

Sesbania species are well-known vegetables in many countries. *Sesbania grandiflora* and *S. javanica* are the most commonly eaten, but other ten species have also been used for food (Table 1). Leaves and flowers of *Sesbania grandiflora* have been sold in markets in Malaysia, Cambodia and Thailand (Fig. 1). This section provides information about the uses of *Sesbania* species as human food and their nutrition.

Table 1 Food provided by species of *Sesbania*.

Used parts	Common names	Preparation and use	Country or region	Reference
<i>Sesbania bispinosa</i>				
Flowers		vegetables		Tanaka & Nakao, 1976
Pods		substitute for peas		Tanaka & Nakao, 1976
Seeds		vegetables		Tanaka & Nakao, 1976
<i>Sesbania cannabina</i>				
Seeds		vegetables	India	Datta & Banerjee, 1978
<i>Sesbania grandiflora</i>				
Stems	Rang Dok Kae	Young shoot added in curry or dipped in paste	Thailand	Tangtragoon, 1998
Stems	Khae, Khae baan	Young shoots steamed or stir-fried before being eaten with chili paste in many kinds of food, such as curries	Thailand	Thongpairojn, 1999
Stems	Khae baan	Young shoots steamed or boiled or steamed and eaten with other food	Thailand	Chumnasiao, 2004
Stems	Khae baan	Young shoot steamed and eaten with chili paste or added in curries	Thailand	Tangtragoon et al., 2004
Stems	Khae, Khae baan	Young shoot steamed and eaten with chili paste or added in sour curries	Thailand	Srisopa, 2008
Stems	Khae	Young shoot steamed and eaten with chili paste	Thailand	Muangyen, 2013
Stems	Khae dok khao, Khae dok daeng	Young shoot used as a side dish with spicy meat salads	Thailand	Ngamsiri, 2015

Used parts	Common names	Preparation and use	Country or region	Reference
Leaves		Used as a vegetable or spinach-like vegetable by adding in stews and salad		Martin & Ruberté, 1975
Leaves		Fried, steamed, boiled or added in soups or curries	Asia	Rachie, 1979
Leaves	Daəm ɲkɪə dey	Added in soups	Cambodia	Martin, 1971
Leaves	Agse mara, Agasatibak	vegetable	India	Rajasab & Isaq, 2004
Leaves	Agathi keerai	vegetable	India	Arinathan et al., 2007
Leaves	Agathi	vegetable	India	Sarvalingam et al., 2015
Leaves	Toori, Toroj	Eaten as sěpan (food heated in steam) by nursing mothers	Indonesia	Ochse & van den Brink, 1977
Leaves	Agati-keerai, Akatti, Katuru-murunga	vegetable	Sri Lanka	Dasanayake & Fosberg, 1991
Leaves	Khae baan	vegetable	Thailand	Pongpangan & Poobrasert, 1972
Leaves	Kae, Khae	Cooked vegetable	Thailand	Inta, 2008
Leaves	Khae	Steamed and eaten with chili paste	Thailand	Muangyen, 2013
Flowers		Fried, steamed, boiled or added in soups or curries	Asia	Rachie, 1979
Flowers	Daəm ɲkɪə dey	Added in soups	Cambodia	Martin, 1971
Flowers	Geloŭgai	vegetable	China	Pei, 1985
Flowers		vegetable	India	Hedrick, 1972
Flowers	Agse mara, Agasatibak	vegetable	India	Rajasab & Isaq, 2004
Flowers	Agasti phool	vegetable	India	Sinha & Lakra, 2005
Flowers	Bakphul	vegetable	India	Bandyopadhyay & Mukherjee, 2009
Flowers		Eaten in curries	India	Roxburgh, 1874
Flowers	Agasemara, Agasta, Agastya ^a	Eaten in curries [as <i>Agati grandiflora</i>]	India	Nadkarni, 1976
Flowers		Added to salads	Indonesia	Hedrick, 1972

Used parts	Common names	Preparation and use	Country or region	Reference
Flowers	Toori, Toroj	Used for making sayur or lalab or pětjël; sayur is a soup, lalab is a side dish containing several plant ingredients eaten raw with rice and pětjël is the dish made from leafy vegetable covered with a sambal-sauce	Indonesia	Ochse & van den Brink, 1977
Flowers	Getih, Kachang turi, Turi	vegetables	Malaysia	Corner, 1940
Flowers		vegetables	Myanmar	Hedrick, 1972
Flowers	Khae	vegetables	Thailand	Upho, 2005
Flowers		vegetables	Thailand	Boontun, 2010
Flowers	Diang piang, Lum dok kae, Tood rang jaak	vegetables	Thailand	Srithi, 2012
Flowers	Dok kare	vegetables	Thailand	Panyadee et al., 2016
Flowers	Khae baan	Steamed and eaten with hot sauce or added in curries. Pistils should be removed before using.	Thailand	Pongpangan & Poobrasert, 1972; Smitinand, 1990
Flowers	Rang Dok Kae	Steamed and eaten with hot sauce or added in curries. Pistils should be removed before using.	Thailand	Tangtragoon, 1998
Flowers	Khae, Khae baan	Steamed or stir-fried before being eaten with chili paste or added in many kinds of food, such as curries	Thailand	Thongpairojn, 1999
Flowers	Khae Baan	Steamed and eaten with chili paste or added in curries	Thailand	Tangtragoon et al., 2004
Flowers	Kae, Khae	Cooked and eaten as vegetable by the Tai Lue ethnic minority group	Thailand	Inta, 2008

Used parts	Common names	Preparation and use	Country or region	Reference
Flowers	Khae, Khae baan	Steamed and eaten with chili paste or added in sour curries	Thailand	Srisopa, 2008
Flowers	Khae baan	Steamed, fried, stir-fried or added in soups or curry (Fig. 1)	Thailand	Ponpim, 1996; Chumnasiao, 2004; Oundech, 2009; Junkhonkaen, 2012
Flowers	Khae	Steamed, fried, stir-fried or added in soups or curry	Thailand	Yooyen, 2012; Muangyen, 2013
Flowers	Khae dok khao, Khae dok daeng	Steamed, fried, stir-fried or added in soups or curry	Thailand	Ngamsiri, 2015
Flowers	Khae	Added in curries	Thailand	Muangyen, 2013
Flowers	Katuday	vegetables	Philippines	Bodner & Gereau, 1988
Flowers	Agati-keerai, Akatti, Katuru-murunga	vegetables	Philippines	Dasanayake & Fosberg, 1991
Flowers		Petals eaten raw or added in soups	Philippines	Yoshida, 1990
Flowers		vegetables	W Africa	Irvine, 1952
Pods		Added in stews and salad		Martin & Ruberté, 1975; Tanaka & Nakao, 1976
Pods		Fried, steamed, boiled or adding in soups or curries	Asia	Rachie, 1979
Pods		Eaten in curries	India	Roxburgh, 1874
Pods	Agasemara, Agasta, Agastya ¹	Eaten in curries [as <i>Agati grandiflora</i>]	India	Nadkarni, 1976
Pods	Toori, Toroj	Eaten as sĕpan, especially by nursing mothers	Indonesia	Ochse & van den Brink, 1977
Pods	Khae baan	vegetable	Thailand	Pongpangan & Poobrasert, 1972
Pods	Khae, Khae baan	Steamed or stir-fried before being eaten with chili paste or added in many kinds of food, such as curries	Thailand	Thongpairojn, 1999
Pods	Dok kare	Young pods steamed and eaten as vegetables	Thailand	Tovaranonte, 2003

Used parts	Common names	Preparation and use	Country or region	Reference
Pods	Khae dok khao, Khae dok daeng	Young pods Used as a substitute for papaya to make salad	Thailand	Ngamsiri, 2015
Seeds		Processed and used in the same way as soybeans	Asia	Rachie, 1979
Seeds	Toori , Turi	Used to make tempeh turi; tempeh is a fermented bean cake usually made from bean seeds. Tempeh turi is popular in east and central Java	Indonesia	Shurtleff & Aoyagi, 1979
<i>Sesbania javanica</i>				
Leaves	Sano	vegetables	Thailand	Pongpangan & Poobrasert, 1972
Flowers	Daəm snao	to make donuts	Cambodia	Martin, 1971
Flowers		Used for making rice cake [as <i>S. paludosa</i>]	SE Asia	Lecomte et al., 1912
Flowers		vegetables	Thailand	Srithi, 2012
Flowers	Sano	Steamed, fried, stir-fried, added in sour curry or mixed with eggs to make omelets	Thailand	Pongpangan & Poobrasert, 1972; Thongpairojn, 1999; Humphanon et al., 2002
Flowers	Dok khanoo, Sano kin dok	To make a dessert called ‘Khanom Dok Sano’. [‘Khanom’ means a dessert, ‘Dok’ means a flower and ‘Sano’ is the vernacular name of this species in Thai language]	Thailand	Tovaranonte, 2003
Flowers	Phak hong haeng, Sano, Sano kin dok, Sano hin	Steamed, fried, stir-fried, added in sour curry or mixed with eggs to make omelets. Moreover, flowers used to make a dessert called ‘Khanom Dok Sano’(Fig. 1).	Thailand	Srisopa, 2008

Used parts	Common names	Preparation and use	Country or region	Reference
Flowers	Sano, Sano kin dok	Steamed, fried, stir-fried, added in sour curry or mixed with eggs to make omelets. Moreover, flowers used to make a dessert called ‘Khanom Dok Sano’.	Thailand	Ngamsiri, 2015
Flowers		Added to chocolate balls to make healthy snack	Thailand	Leelasuphapong, 2013
Flowers		Added to ice cream to make a healthy snack	Thailand	Chaweewan, 2013
<i>Sesbania longifolia</i>				
Seeds		coffee substitute	Mexico	Hedrick, 1972
<i>Sesbania pachycarpa</i>				
Seeds		coffee substitute	Senegal	Kerharo & Adam, 1964
Seeds		substitute for seeds of <i>Parkia</i> to make a fermented extract called soumbara	W Africa	Dalziel, 1937
<i>Sesbania sericea</i>				
Seeds		coffee substitute [as <i>S. pubescens</i>]	Senegal	Kerharo & Adam, 1964
<i>Sesbania sesban</i>				
Leaves		Added in traditional salad called ‘Singju’	India	Konsam et al., 2016
Leaves		vegetables	India	Pullaiah et al., 2016
Flowers		vegetables [as <i>S. aegyptiaca</i>]	W Africa	Irvine, 1952
Pods		substitute for peas		Tanaka & Nakao, 1976
Pods		Boiled and mashed with potatoes or peas, chili, and fermented fish	India	Konsam et al., 2016

Used parts	Common names	Preparation and use	Country or region	Reference
		into a semi-liquid dish called 'Eromba'		
Seeds		Fermented into a flavoring paste [as <i>S. aegyptiaca</i>]	W Africa	Dalziel, 1937
<i>Sesbania sesban subsp. punctata</i>				
Seeds		Substitute for seeds of Parkia to make a fermented extract called 'soumbara'	W Africa	Dalziel, 1937
<i>Sesbania speciosa</i>				
Flowers		Steamed or stir-fried with eggs	Thailand	Personal observation
<i>Sesbania tetraptera</i>				
Leaves		Potherb	Tropical Africa	Tanaka & Nakao, 1976

^a See Appendix 4 for additional common names of *Sesbania grandiflora* cited by Nadkarni (1976)

Fig. 1 *Sesbania* flowers used as food in Thailand. **a** Flowers of *Sesbania grandiflora* with other vegetables at a market in Chiang Rai province. They are used as the ingredients in a traditional northern curry 'Kaeng Khae'. 'Kaeng' means curry and 'Khae' is the common name of *Sesbania grandiflora* in Thai language. **b** Flowers of *Sesbania javanica* at a market in Sukhothai province. **c** Flowers of *Sesbania grandiflora* in Thai sour curry 'Kaengsom dok khae' (thaifood4.wordpress.com). **d** Steamed flowers of *Sesbania javanica*. **e** flowers of *Sesbania javanica* in omelet. **f** A Thai dessert 'Khanom dok sano' (lekkathaifood.blogspot.com).

Nutritional value of Sesbania. The many uses of *Sesbania* for human food are surely related to the delicious taste of many parts from many species, but *Sesbania* species also provide important nutrition. Here we provide information about the nutritional value of the different parts of these species.

Sesbania bispinosa — Seeds contained 39% protein² (Prakash & Misra, 1988). Another study of seed nutrition found that 100 g of seed flour contained 6.81 g of total dietary fiber, 6.23 g of crude lipid, and 31³ g of crude protein whereas the content of total protein was 22 g. The in vitro protein digestibility was 66%. Moreover, the content of calcium, magnesium, phosphorus, potassium, and sodium were 269 mg, 208 mg, 336 mg, 827 mg, and 112 mg respectively whereas the content of copper, iron, manganese and zinc were 0.96 mg, 7.42 mg, 0.76 mg, 4.38 mg, respectively. Furthermore, it contained 1% of total free phenols, 1% of tannin, and 2% of L-Dopa (Pugalenthi et al., 2004). One hundred g of *Sesbania bispinosa* [as *S. aculeata*] dry seeds contained 33 g of crude protein, 6.0 g of crude lipid, 11 g of crude fiber, 20 g of total starch with 10 g of digestible starch, 3.08 g of total phenols, 2.25 g of tannins, 1.89 g of condensed tannins, 2.16 g of phytate and 0.52 g of saponin (Hossain & Becker, 2001). High β -sitosterol content and high stigmasterol content were found in shoots (0.15 mg/g dw and 0.14 mg/g dw, respectively) whereas lower β -sitosterol content was found in fruits (0.11 mg/g dw) and lower stigmasterol content was found in roots (0.08 mg/g dw) (Kapoor & Purohit, 2013).

Sesbania grandiflora — Edible parts contained per 100 g, 1.08 gram of fat, 0.09 g of linoleic acid, and 0.48 g of α -linoleic acid (Ghafoorunissa & Pangrekar, 1993). Young shoots contained per 100 g, 7.97 mg of iron, 145 mg of vitamin C, 1184 mg of phytate, 2.57 mg of crude fiber (Laohabutr, 2000). Young tips and leaves contained per 100 g, 72 mg of vitamin C, 63 mg of tannin, and 13 g of phytate. However, the contents of vitamin C, tannin, and phytate was reduced by heating (Somsut et al., 2008). Leaves contained per 100 g, approximately 11 mg of total carbohydrate, 0.715 mg of protein, 0.225 mg of amino acids, 3.43 mg of vitamin B1, and 10 mg of vitamin B2 (Anitha and Josephine, 2014). Leaves contained per 100 g of dry matter, 145 mg of lutein and 7.1 mg of zeaxanthin (Liu et al., 2007). One hundred g leaves contained 45 mg of total carotene with 15 mg of β -carotene (Bhaskarachary et al., 1995). One hundred grams of dry leaves contained 1.8 mg of neoxanthin, 4.3 mg of violaxanthin, 17 mg of lutein, 0.57 mg of zeaxanthin, 13 mg of β -carotene (Lakshminarayana et al., 2005). The edible portion of leaves had the concentration of total phenols, total chlorophyll, and total carotene of 11 mg GAE/g dw, 26 μ g/g dw, and 2.29 mg/g dw respectively (Gunathilake & Ranaweera, 2016). Ten grams young leaf and flower extracted with metaphosphoric acid contained 164 ml of vitamin C (Sornsawad & Kaewkhamhom, 2003). Flower extracts had carbohydrates, proteins, amino acids, glycosides, flavonoids, alkaloids, tannins, polyphenols, and saponin (Mallik & Nayak, 2011). One hundred g of edible portion of flowers contained 26 g of protein, 2.2 g of fat and 47 g of carbohydrate (Maisuthisakul et al., 2008). One hundred grams of fresh flowers contained 2.4 g of protein, 21 mg of flavonoids, 38 mg GAE of total phenols with 0.04 mg of phenolic acid, 0.22 mg of total anthocyanin, 0.36 mg β CE of total carotenoid with 0.01 β -carotene, and 34 mg of vitamin C (Andarwulan et al., 2012). It was found that 3 cm long petals contained the highest amount of anthocyanin (455 μ g/g FW) and the hypocotyls contained anthocyanin and the highest amount of anthocyanin in hypocotyls was found in 7-day-old seedlings (290 μ g/g FW) (Bodhipadma et al., 2006). Seeds contained 40% of protein (Rachie, 1979).

Sesbania javanica — Flowers contained per 100 g, 15 mg of vitamin C, 50 mg of tannin, and 8 g of phytate. Stir-frying was a better cooking process because the content of vitamin C was

² Throughout this paper we use only entire numbers for percentages, even if the original reference may have used decimal point

³ For weight (g, mg) decimals are included only for numbers <10, otherwise they were shortened to the nearest whole number.

reduced less than in blanching and boiling (Somsu et al., 2008). Seeds contained 41% of protein (Prakash & Misra, 1988).

Sesbania pachycarpa — Seeds contained 25 g of protein per 100 g (Ezeagu et al., 2002). Another study of nutrition reported that *Sesbania pachycarpa*, called Cecego or Tchetcheko in Niger, contained 36% of protein and higher amounts of essential amino acids than *Crateva religiosa* and *Brassica oleracea* [as *B. oleracea* var. *capitata*]. *Sesbania pachycarpa* also contained 1.11 mg/g dw of total fatty acids with 126 µg/g dw of linoleic acid and 225 µg/g dw of α-linoleic acid. Moreover, it contained 15,000 µg/g dw of calcium, 3,460 µg/g dw of phosphorus, 13,600 µg/g dw of potassium, 285 µg/g dw of sodium, 852 µg/g dw of magnesium, 0.45 µg/g dw of cobalt, 9.90 µg/g dw of copper, 260 µg/g dw of iron, 46 µg/g dw of manganese and 40 µg/g dw of zinc (Glew et al., 2005).

Sesbania rostrata — One hundred g of dry seeds contained 32 g of crude protein, 4.7 g of crude lipid, 11.8 g of crude fiber, 20 g of total starch with 8.6 g of digestible starch, 2.96 g of total phenols, 1.99 g of tannins, 2.52 g of condensed tannins, 1.89 g of phytate and 0.50 g of saponin (Hossain & Becker, 2001).

Sesbania sesban — Seeds contained 39% of protein (Prakash & Misra, 1988). One hundred g dry seeds contained 29–32 g of crude protein, 5–6 g of crude lipid, 16 g of crude fiber, 18–19 g of total starch with 7.2–7.4 g of digestible starch, 4.85–5.95 g of total phenols, 1.97–2.02 g of tannins, 5.05–5.14 g of condensed tannins, 2.35–2.37 g of phytate and 1.26–1.46 g of saponin (Hossain & Becker, 2001).

Overall, we found references for ten *Sesbania* species that are used as human food. The most used species was *Sesbania grandiflora*, possibly because it is a perennial plant with large leaves and flowers compared to other *Sesbania* species. The large flowers make it easier to remove the pistil so the flowers are not as bitter as flowers of other *Sesbania* species. The flower is mostly used because it is softer and tastier than other parts. There are different cooking processes depending on countries and used parts. For example, young shoot, leaves, and flowers are eaten scalded and added in soup or curries in Thailand, but they are eaten fresh in some countries such as Indonesia. *Sesbania* species could be promoted as human food, especially in rural areas where people may have limited access to food and suffer nutrition deficiency. According to the information about nutritional content of *Sesbania* that we have found, seeds of *Sesbania* species contained high amounts of protein and some *Sesbania* species contained high vitamin C and some minerals. In addition, some of them contained high amounts of tannin and phytate which are antinutrients, but these antinutrients are reduced by heating. Antinutrients are compounds that interfere with the absorption of nutrients (Attwood et al., 2006). Tannins reduce the absorption of manganese (Yildiz, 2009), calcium, and iron (Ashok & Upadhyaya, 2012) whereas phytate affects the absorption of calcium, copper, iron, magnesium, and zinc (Attwood et al., 2006). The effect of antinutrients in calcium uptake have been demonstrated (Amalraj & Pius, 2015). The calcium amount of *Sesbania grandiflora* was 666 mg/100g which was higher than that of the species it was compared to, *Centella asiatica*, which contained 498 mg/100g. However, the calcium bioavailability of *S. grandiflora* was only 15% which was lower than that of *C. asiatica* in which it was 33%. According to the same study, *S. grandiflora* contained higher amount of oxalate, phytate, and tannin than *C. asiatica*. The amount of these antinutrients were negatively correlated with calcium bioavailability. The negative correlation between antinutrients and calcium bioavailability in *Sesbania grandiflora* was already demonstrated by Kamchan et al. (2004) who measured the

amount of oxalate, phytate, and dietary fiber as antinutrients. Tannin and phytate in contrast have known medicinal properties. The medicinal properties of tannin and other phytochemicals are further discussed under medicines.

2. Animal food and nutrition

Eleven species of *Sesbania* have been reported to serve as food for animals, mostly cattle, but also other domestic animals such as camel, donkeys, goats, and sheep. Most reports of the use of *Sesbania* for animal feed mention positive effects on growth, but a single report suggests that feeding the endosperm of *Sesbania* seeds to fish reduce their growth. There are a few reports of wild animals that feed on *Sesbania*, including the flying fox bat in Thailand and elephants in Tanzania and Zambia.

Fertile Plant Parts. In the Turkana area of Kenya fresh flowers and fruits of *Sesbania sericea* and *Sesbania sesban* var. *nubica* are fed to cattle (*Bos Taurus*), camels (*Camelus* sp.), donkeys (*Equus africanus asinus*), goats (*Capra aegagrus hircus*), and sheep (*Ovis aries*) (Morgan, 1981).

Aerial Parts. In West Bengal *Sesbania cannabina* is used as a fodder for cattle, sheep and goats (Datta & Banerjee, 1978). Leaves of *Sesbania grandiflora* are used as a source of green fodder for cattle (Martin & Ruberté, 1975). In Thailand flowers of *Sesbania grandiflora* are eaten by flying fox bats (*Pteropus* sp.) (Culbertson, 1894). In three northeastern provinces (Chaiyaphum, Khon Kaen, and Nakhonratchasima) of Thailand leaves of *Sesbania grandiflora* are boiled to feed domestic animals (Vorachinda, 1986). In Java, the tree is much planted for forage and continuously topped to keep it within the animals' reach. The disadvantage of *Sesbania grandiflora*, when it is used as a forage, is that its foliage is less digestible than that of *Leucaena leucocephala*, which is a common weedy shrub that often grows together with *Sesbania grandiflora*. Moreover, *Sesbania* plants regenerate more slowly after being browsed. Fresh young foliage is palatable to livestock and boosts the growth of both cattle and sheep (Rachie, 1979). In India leaves and tender parts are eaten by cattle (Roxburgh, 1874). In Sri Lanka leaves of *Sesbania grandiflora* are used as fodder for cattle (Dasanayake & Fosberg, 1991). In Africa *Sesbania keniensis* is browsed by all stock (Gillett, 1963). A study of the effect of feeding *Sesbania* leaves to goats showed that goats that eat *Sesbania rostrata* had the highest mean value for average daily live weight gain, and the study suggested encouraging *Sesbania rostrata* for feeding goats (Shahjalal & Topps, 2000). In Turkana in Kenya roots of *Sesbania sericea* and *Sesbania sesban* var. *nubica* are cooked and fed to cattle, camel, donkeys, goats, and sheep (Morgan, 1981).

Unspecified parts. In Guayas Province of Ecuador *Sesbania emerus* is used to feed goats (de la Torre et al., 2008). In Puna Island of Ecuador, *Sesbania emerus*, called Mostaza or Mostaza de Monte, is also eaten by goats (Madsen et al., 2001). In Tanzania *Sesbania keniensis* is eaten by elephants (*Loxodonta africana*) whereas elephants in Zambia eat *Sesbania greenwayi*. In Somalia *Sesbania quadrata* is eaten by sheep, goats and camels. In Ethiopia and Somalia *Sesbania somalensis* is eaten by all stock (Gillett, 1963). *Sesbania sesban* could be used as a supplement food for sheep because sheep fed with *S. sesban* produced more milk and gained more weight (Mekoya et al., 2009).

Nutrition. Leaves of *Sesbania grandiflora*, used to feed cattle in Khon Kaen province of Thailand, contained 26% of protein, 4% of fat, 13% of fiber, 36% of water soluble carbohydrate, 3% of calcium, and <1% of phosphorus (Vorachinda, 1986).

3. Poisons

The seeds of four species of *Sesbania* are known to have poisonous effects on vertebrates or to reduce growth, which must be taken into account when using *Sesbania* as animal feed.

Vertebrate poisons. One oz. (about 28 g) of *Sesbania drummondii* seeds could kill sheep (*Ovis aries*) and two oz. (about 56 g) could kill larger animals, and seeds of *Sesbania vesicaria* are also toxic to animals; however, the dose was not cited (McGinty & Machen, 1993). Seeds of *Sesbania vesicaria* [as *Glottidium vesicarium*] are toxic to chicken (*Gallus gallus domesticus*) and fish (guppy, *Poecilia reticulata* and minnow, *Phoxinus phoxinus*). Chicken could survive for three days when they were fed with 10% dry ground seeds and saponin was the toxin causing death. Guppies could survive for 34 minutes and minnows could survive for 54 minutes when they were fed with 0.01% and 0.002% saponin from *S. vesicaria* seeds, respectively (Hsu, 1968). The endosperm of *Sesbania bispinosa* [as *S. aculeata*] reduced growth in carp (*Cyprinus carpio*), tilapia (*Oreochromis niloticus*) and affected their nutrient absorption (Hossain et al., 2001). Although *Sesbania* species are good sources of protein and can be used as animal food, the amount of *Sesbania* seeds should be of concern when they are used. Hossain et al. (2002) suggested that the level of raw seeds of *Sesbania bispinosa* which did not affect to growth of tilapia was up to 10%.

Non-vertebrate poisons. In the western part of Thailand *Sesbania grandiflora* is used as a fungicide and bactericide. One kilogram of *Sesbania grandiflora* bark is ground and soaked in 20 liters of water for 24 hours. Then 20 milliliters of the extraction mixed with 20 liters of water are sprayed over crops every 5–7 days. Moreover, the same formula can be used to kill root-knot nematodes (*Meloidogyne* sp.) (Suk-ueng, 2006).

Plant inhibitors. It was found that sesbanimide from *Sesbania bispinosa* and *S. punicea* could inhibit seed germination and seedling growth of some plants such as cucumber (*Cucumis sativus*) and lettuce (*Lactuca sativa*) (van Staden & Grobbelaar, 1995). Catechin from *Sesbania virgata* seeds could reduce root biomass in *Arabidopsis thaliana* and rice (*Oryza sativa*). Moreover, it inhibited lateral root formation of *Arabidopsis thaliana* (Simões et al., 2008). Allelopathic properties of sesbanimide and catechin facilitate *Sesbania* success as an invasive.

4. Medicines

This section gives information about 10 *Sesbania* species which have been used as traditional medicines to treat over diseases and other health conditions in over 20 categories (Table 2). The possible pharmacological basis for using these species in traditional medicine are reviewed below.

Circulatory System Disorders. Aqueous suspensions of *Sesbania grandiflora* showed positive effects on membrane-bound ATPase activities. It increased the activities of Na⁺-K⁺ ATPase, Ca⁺ ATPase, and Mg²⁺ ATPase in cigarette smoke exposed rats. Membrane-bound ATPases are enzymes that maintain vascular homeostasis. The inhibition of these enzymes can cause vascular diseases (Ramesh et al., 2007). An aqueous suspension of *Sesbania grandiflora* exhibited cardioprotective activities in the heart of cigarette smoke-exposed rats. It decreased lactate dehydrogenase (LDH) activity and the value of thiobarbituric acid reactive substances (TBARS) whereas it increased superoxide dismutase activity, catalase activity, glutathione (GSH) level,

GSH-related enzyme activities. It also increased levels of vitamin C, vitamin E, zinc, manganese, and selenium. However, the cardioprotective activities were not found in normal rats treated with the suspension (Ramesh et al., 2008). The damage in rat heart may activate chemicals in *Sesbania grandiflora* suspension to work.

Digestive System Disorders. As shown in under the human food category, leaves of *Sesbania grandiflora* and flowers of *Sesbania javanica* contained high amounts of tannin (Somsab et al., 2008). Bahera et al. (2012), reported that leaf and bark of *Sesbania grandiflora* contained tannin; however, tannin content was not reported in that study. Tannins are known as effective treatments of diarrhea because of its astringent properties. We have not found evidence of the tannin pentagalloylglucose in *Sesbania*, which is known to inhibit H^+K^+ ATPase, which causes stomach acidification. Pentagalloylglucose can therefore be used to treat gastritis and peptic ulcer (Polya, 2003). The uses mentioned above of *Sesbania* to treat gastric ulcer could therefore possibly be due to presence of pentagalloylglucose.

Endocrine System Disorders. *Sesbania grandiflora* flower contain crude protein which exhibited inhibition of α -glucosidase (Boonmee et al., 2007). Alpha-glucosidase breaks down carbohydrates to glucose (Berg et al., 2002) so the α -glucosidase inhibitor helps to reduce the level of glucose. Moreover, roots, shoots, and fruits of *Sesbania bispinosa* (Kapoor & Purohit, 2013) and flowers of *Sesbania grandiflora* (Cayme & Ragasa, 2004) contain stigmasterol, a phytosterol which has hypoglycemic properties by reducing serum glucose concentration and the activity of glucose-6-phosphatase (Panda et al., 2009). Glucose-6-phosphatase is an enzyme which hydrolyzes glucose-6-phosphate into phosphate group and glucose. Leaves of *Sesbania bispinosa* contained pinitol which is a natural product exhibiting hypoglycemic activities (Misra & Siddiqi, 2004). *Sesbania sesban* showed the potential to reduce blood glucose from the highest blood glucose value in albino rats fed with ethanolic leaf extracts and pure leaf ash of *Sesbania sesban* were low compared to control groups. Moreover, the 3-hour values in rats fed with the extracts and pure ash were lower than 0-hour values whereas the 3-hour values in control groups were near 0-hour values (Kar et al., 1999).

Genitourinary System Disorders. Leaf juice of *Sesbania grandiflora* exhibited antiurolithiatic activity. It did not only reduce calcium and oxalate accumulation in kidneys, but it also reduced urinary excretion of calcium and oxalate (Doddola et al., 2008). Oleanolic acid 3- β -D-glucuronide from root extract of *Sesbania sesban* had spermicidal activity. It induced 100% immobilization of sperm at the minimum concentration of 50 μ g/ml (Das et al., 2011).

Immune System Disorders. The methanolic extract of *Sesbania grandiflora* increase inert immune response, IgG (Immunoglobulin G) and IgM (Immunoglobulin M) levels so it was suggested that it could be used to treat immunodeficiency diseases, cancer and also combined with other antibiotics (Arunabha & Satish, 2015).

Infections/ Infestations. The methanolic extract of *Sesbania bispinosa* root, stem and leaves could inhibit *Staphylococcus aureus* with 11-millimeter diameter of clear zone, but it could not inhibit *Escherichia coli*, *Saccharomyces cerevisiae*, and *Fusarium oxysporum* (Grosvenor et al., 1995). The ethanolic leaf extracts of *Sesbania grandiflora* did not show any antimicrobial effect on *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* (Valsaraj et al., 1997). However, nanosized leaf powder of *Sesbania grandiflora* had higher effect in inhibiting of microorganisms (*Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida*

albicans, and *Aspergillus niger*) than crude leaf powder because the nanosized leaf powder bound to the surface of the cell membrane and quickly affected the microorganisms (Reji & Alphonse, 2013). Another study of antimicrobial activities of *Sesbania grandiflora* which used the extracts from leaves, branches, stem bark, and stem core found that the ethyl acetate and butanol extracts of stem barks had clinically high potential antibacterial activities (Anantaworasakul et al., 2011). Moreover, silver nanoparticles, AGNPs, synthesized with *Sesbania grandiflora* leaf extract showed good effective antipathogenic activities (Ajitha et al., 2016). The aqueous extracts of *Sesbania grandiflora* leaves and flowers showed antibacterial activities against *Bacillus subtilis* with 15-millimeter diameter of clear zone, but it did not inhibit 13 other microorganisms (Srinivasan et al., 2001). Fruits of *Sesbania grandiflora* also showed antibacterial activity and their extracts inhibited *Mycobacterium tuberculosis* at the minimum concentration of 1600 µg/ml (Mohamad et al., 2011). The leaf extracts of *Sesbania macrantha* and *S. sesban* var. *nubica* could not inhibit *Bacillus subtilis*, *Candida albicans*, *Mycobacterium smegmatis*, *Pseudomonas aeruginosa*, *Salmonella enterica* subsp. *enterica* serovar [as *Salmonella gallinarum*], and *Staphylococcus aureus* (Boily & Van Puyvelde, 1986); however, the methanolic leaf extracts of *Sesbania macrantha* showed antimicrobial activities against *Neisseria gonorrhea* and *Neisseria meningitides* (van Puyvelde et al., 1983). Ethyl acetate extract of *Sesbania punicea* inhibited *Salmonella enterica* subsp. *enterica* serovar Paratyphi B [as *Salmonella paratyphi* B], *Streptococcus agalactiae*, *Staphylococcus saprophyticus*, *Salmonella typhi*, and *Shigella flexneri*, but it did not inhibit *Streptococcus mutans*, *Staphylococcus aureus*, and *Escherichia coli* (Jamzad et al., 2014). The methanolic extracts of *Sesbania sesban* leaves could inhibit *Neisseria gonorrhea* and *Neisseria meningitides* (van Puyvelde et al., 1983). Leaf and stem extracts from *Sesbania sesban* [as *S. aegyptiaca*] had no microbial activity against *Trichophyton rubrum* and *Aspergillus niger* (Gupta & Banerjee, 1972). Leaves and twigs of *Sesbania sesban* extracted by using hexane could inhibit *Bacillus cereus* at the concentration of 250 µg/ml and 500 µg/ml, respectively. The extracts of leaves, twigs and methanolic root extracts exhibited very weak activities against *Staphylococcus aureus*, *Aspergillus niger*, *Candida albicans*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Salmonella typhimurium* because the minimum concentration of extracts needed in inhibition were at or above 1000 µg/ml. Moreover, although the antiviral inhibitory concentration of *Sesbania sesban* extract was not shown, the study reported that the twig extracts had weak activities against viruses whereas the leaf and root extracts had no activities (Maregesi et al., 2008). The methanolic extract of *Sesbania sesban* petals could inhibit *Staphylococcus aureus* and *S. saprophyticus* with five-millimeter diameter and two-millimeter diameter of clear zone respectively, but it could not inhibit *Escherichia coli*, *Klebsiella pneumoniae*, *K. oxytoca*, *Proteus vulgaris*, *Streptococcus pyogenes*, *Pseudomonas aeruginosa*, and *Enterococcus faecalis* (Kathiresan et al., 2012). Methanolic extracts of *Sesbania sesban* could be used to treat schistosomiasis. It could reduce the number of *Schistosoma mansoni* adults by 75%, eggs in the intestine by 74% and eggs in the liver by 74% when infected mice were treated with 1000 mg/g of the extracts (El-Emam et al., 2015).

Overall, six *Sesbania* species have been used in traditional medicine to treat infections. Some of them were tested for their antimicrobial activities. Moreover, although *Sesbania macrantha* and *S. punicea* are not used as ethnomedicines for infection treatment, they were tested for antimicrobial activities. Regarding the chemical substances which have antimicrobial properties, polyphenol extracts of *Sesbania grandiflora* flower inhibited *Escherichia coli*, *Staphylococcus aureus*, *Salmonella typhi*, *Shigella flexneri*, and *Vibrio cholera* (China et al., 2012). Moreover, isovestitol, medicarpin, sativan, and betulinic acid from *Sesbania grandiflora* root inhibited *Mycobacterium*

tuberculosis. The minimum inhibitory concentration of isovestitol, medicarpin, and sativan was 50 µg/mL whereas that of betulinic acid was 100 µg/mL (Hasan et al., 2012). *Sesbania grandiflora* has been the only species recorded in traditional treatment of infestation. *Sesbania sesban* proved to be a potential treatment of infestation. Although there is no evidence, some other *Sesbania* species may also have potential in treatment of endoparasites and ectoparasites because they contained toxins, such as saponin and sesbanimide.

Inflammation. The study of anti-inflammatory potential of *Sesbania bispinosa* leaves in Swiss albino mice demonstrated that methanolic extract had the highest efficacy in the decrease of paw edema. Although all three fractions (ethyl acetate, acetone, and petroleum ether) of methanolic extracts markedly inhibited inflammation, the ethyl acetate fraction had the highest efficacy. Regarding the result of that study, the acetone fraction was a more effective inhibition of early phase of inflammation whereas petroleum ether was more effective in the late phase (Boddawar et al., 2016).

Analysis of leaves of *Sesbania bispinosa* [as *S. aculeata*] showed that 1-O-β-D-glucopyranosyl-2-hydroxy-N-pentadecanamide, 2-hydroxy-N-decanamide, and triterpene acid 3-O-α-L-rhamnopyranoside significantly inhibited TNF-α, Tumor Necrosis Factor α whereas 2-hydroxy-N-decanamide significantly inhibited IL-6, Interleukin 6. TNF and IL are pro-inflammatory cytokines (Sharma et al., 2014). Crude saponin from *Sesbania sesban* leaves showed inflammatory effects. At the dose 500 mg/kg, saponin could inhibit paw edema by 59%, ear edema by 70% and granuloma by 38%. Moreover, 350 µg/mL of *Sesbania sesban* saponin could inhibit hemolysis by 48% and protein denaturation by 51% (Tatiya et al., 2013).

Metabolic System Disorders. The study of hypolipidemic activity of *Sesbania grandiflora* leaves showed that the aqueous extract of its leaves did not only significantly reduce the levels of several kinds of lipids, but also significantly increased serum HDL level (Saravanakumar et al., 2011); HDL or High Density Cholesterol is “good” cholesterol that reduce and remove LDL (“bad” cholesterol) and transport them to liver where cholesterol is proceeded and converted to bile salts (Nelson & Cox, 2012).

Muscular-Skeletal System Disorders. Stigmasterol found in *Sesbania grandiflora* and *S. bispinosa* (Cayme & Ragasa, 2004; Kapoor & Purohit, 2013) had anti-osteoarthritic activities through several mechanisms such as reducing MMP-3 gene expression. MMP-3 or matrix metalloproteinase-3 is an enzyme being responsible for the breakdown of extracellular matrix proteins such as collagens and elastin. Overexpression of this enzyme leads to osteoarthritis (Gabay et al., 2010).

Neoplasms. Ethanolic leaf extract of *Sesbania grandiflora* had tumor-suppressive activity. The concentration at 30 µg/ml could reduce 50% of Hela cell growth (Mackeen et al., 1997). Ethanolic bark extract of *Sesbania grandiflora* inhibit breast cancer and leukemia cell growth (IC₅₀ values 7.00±0.08 µg/mL and 18.50±0.60 µg/mL respectively) (Jain & Jain, 2011). The flower extract of *Sesbania grandiflora* was used to treat leukemia by inducing apoptosis and autophagy through several mechanisms such as phosphatidylserine externalization, activation of reactive oxygen species formation, induction of Caspase-dependent and Caspase-independent death of leukemia cells, alteration of autophagic protein levels (Roy et al., 2013).

Sesbanimide extracted from the seeds of *Sesbania vesicaria* showed cytotoxic activity. It inhibited murine leukemic (L1210) with IC₅₀ value at 0.8 ng/ml (Kim et al., 1992). Besides *S. vesicaria*,

sesbanimide were also found in seeds of *S. drummondii* and *S. punicea*. The concentrations of sesbanimide in *S. drummondii*, *S. punicea*, and *S. vesicaria* were 52 µg/g, 90 µg/g, and 18 µg/g, respectively (Powell et al., 1990). Saponins isolated from *Sesbania vesicaria* seeds did not inhibit DNA topoisomerase I and had no cytotoxic activity against A549 human lung adenocarcinoma epithelial cells (Yuan et al., 2013) although some saponins from *Aesculus pavia* L. had DNA topoisomerase I inhibition activity (Wang et al., 2010). Topoisomerase I is an enzyme which cut one of the strands of DNA, relax, and reseal the strand (Karp, 2009). Tannins which are found in *Sesbania* species, such as *Sesbania grandiflora* (Mallik & Nayak, 2011) and *Sesbania sesban* (Hossain & Becker, 2001), are compounds which have antitumor activity (Polya, 2003).

Nervous System Disorders. *Sesbania grandiflora* leaves could be used to treat depression due to its CNS depressant effect in mice. Mice fell asleep within 30 minutes after being treated with leaf extracts (Sutradhar & Choudhury, 2012).

Nutritional Disorders. The study of seasonal variation of lipid and alkaloids in bark, leaves, and wood of *Sesbania herbacea* [as *S. exaltata*], *Sesbania rostrata*, and *Sesbania sesban* showed that both lipid and alkaloid content were highest during the summer. The highest level of both lipid content and alkaloid were found in leaves of *Sesbania rostrata* (Kadam et al., 2013).

Anthocyanins extracted from *Sesbania sesban* petals had antioxidant activities. Its acidified methanolic extracts exhibited the ability to scavenge hydrogen peroxide; at 1 mg/ml concentration, the extracts exhibited 85% hydrogen peroxide scavenging activity. Moreover, when the concentration of the extracts increased, the malonaldehyde formation decreased (Kathiresh et al., 2012).

Pain. Leaf extracts of *Sesbania grandiflora* had analgesic activities. The dose of 250 mg/g and 500 mg/g of leaf extracts produced 68% and 86% inhibition of writhing response. *Sesbania grandiflora* leaves therefore can be used as a painkiller (Sutradhar & Choudhury, 2012).

Pregnancy/Birth/Puerperium Disorders. In Malaysia leaves of *Sesbania grandiflora* are used in two formulae for postnatal care. The first formula contains 12 ingredients: rhizome of *Acorus calamus*, bark of *Alyxia stellata*, stem bark of *Cinnamomum zeylanicum*, flower bud of *Eugenia aromatica*, fruit of *Foeniculum vulgare*, flower of *Illicium tenuifolium*, seed of *Nigella sativa*, rhizome of *Peucedanum japonicum*, berry of *Piper cubeba*, root of *Rheum officinale*, leaf of *Sesbania grandiflora*, and rhizome of *Zingiber cassumunar*. All ingredients are ground, mixed with water and applied on the forehead for eyesight improvement. The second formula contains six ingredients: rhizome of *Acorus calamus*, stem bark of *Cinnamomum zeylanicum*, flower bud of *Eugenia aromatica*, berry of *Piper cubeba*, fruit of *Piper nigrum*, and leaf of *Sesbania grandiflora*. All ingredients are ground, mixed with water and applied on the forehead to improve eyesight and freshen the body (Jamal et al., 2011).

Sensory System Disorders. *Sesbania grandiflora* leaves contain lutein and zeaxanthin (Liu et al., 2007). Lutein and zeaxanthin are compounds that have antioxidant free radical scavenging activity against age-related macular degeneration (AMD) by absorbing blue light. AMD is a disease which can cause blindness (Polya, 2003).

Skin/Subcutaneous Cellular Tissue Disorders. Roots of red flower of *Sesbania grandiflora* mixed with root of stramonium (we presume from *Datura stramonium*) is used as a paste by applying it to the affected areas (Khory & Katrak, 1903; Nadkarni, 1976).

Veterinary medicine. Leaves of *Sesbania bispinosa* are used as a paste to treat diarrhea in cattle and sheep in Moradabad district in India (Ali, 1999). In Rayalaseema of India *Sesbania grandiflora*, called Avisa, is used to treat digestive and eye ailments. Its leaf juice mixed with dried ginger is squeezed into cattle's eyes to treat corneal opacity and inflammation (Keratitis). Seed oil is given to cattle and sheep to treat ruminal disorders and abdominal swelling due to gas (Tympany) (Sudarsanam et al., 1995). In West Java of Indonesia *Sesbania grandiflora*, called Turi, is used as herbal medicine by a fish farmer; however, the information of the usage and the ailments were not specified (Caruso et al., 2013). In India seeds of *Sesbania sesban*, called Dhaincha in the Sariska region, are crushed and given to goats for diarrhea treatment. Furthermore, boiled seeds with fodder are used to treat exposure-diseases in animals (Upadhyay et al., 2011). In Kenya leaves and stems of *Sesbania macrantha* and *Sesbania sesban* are used as tickicide [an agent used to kill ticks] and re-infested prevention by making suspension (Wanzala et al., 2012). The ethanolic extracts from *Sesbania virgata* leaves showed antiherpes activities. The extracts could inhibit viral cytopathic effect of bovineherpes virus and swineherpes virus (Ikuno et al., 2003).

Overall, 10 species of *Sesbania* were recorded as traditional medicines for both humans and animals in 21 countries (Fig. 3). Medicinal *Sesbania* species were mostly used to treat infections and digestive system disorder, especially diarrhea. *Sesbania grandiflora* is the most used medicinal species and *S. sesban* is the second most used species. The reason why *S. grandiflora* is most used may be because it is widely distributed as both a native and a cultivated species. Due to the conspicuous and tasty flowers, people grow it as an ornamental plant and for food which makes it easier available as a medicine compared to other *Sesbania* species. Furthermore, it is a tree with larger flowers and leaves, so it is easier to collect large amounts of it compared to other *Sesbania* species. However, the same reasons cannot be used to explain why *S. sesban* is the second most used species because the flowers are much smaller than those of *S. grandiflora*. Although leaves, flowers, pods, and seeds of *S. sesban* are edible, it is much less appreciated as a food than *S. grandiflora* (see more details in the section on 'human food'). People grow *S. sesban* for other purposes than medicine, such as hedges or green manure. The reason for *Sesbania sesban* being the second most used *Sesbania* species may be because it is a perennial tree whereas most other *Sesbania* species are annual herbs or subshrubs. *Sesbania sesban* parts used as medicines can be collected in large amount from a few individuals compared to other *Sesbania* species, except for *S. grandiflora*. Because of the abundant literature mentioning the uses of *S. grandiflora* and *S. sesban* as medicinal plants, they have also been of interest in pharmaceutical experiments. Most of experiments confirmed the usefulness of both species as medicines. Apart from these two species, other species have also been tested for their medicinal properties. For example, *S. vesicaria* had positive cytotoxic activity against leukemia although it was not used in traditional cancer treatment. Some traditional medicinal uses of *Sesbania* have not yet been tested, such as using *Sesbania grandiflora* as an antidote to snake venom. Further medicinal research on *Sesbania* species could provide benefits for poor people.

Table 2 Uses of *Sesbania* species for traditional medicine.

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
Abnormalities						
<i>S. grandiflora</i>	Leaves and flowers	Nasal polyps	Khae Ban	Thailand		Niyomyat, 1999
<i>S. hirtistyla</i>		Rectal prolapse		Tanzania	Decoction	Chhabra et al., 1990
Circulatory System Disorders						
<i>S. grandiflora</i>	Leaves	Cardiotonic agent	Khae Ban	Thailand		Niyomyat, 1999
<i>S. pachycarpa</i>	Fruits	Hypertension	More	Burkina Faso	Decoction	Nadembega et al., 2011
<i>S. sesban</i>	Roots	Hypertension	Muzimbandeya	Uganda		Tugume et al., 2016
Digestive System Disorders						
<i>S. grandiflora</i>	Bark	Stomach disorders/Emetic				Martin & Ruberté, 1975
<i>S. grandiflora</i>	Bark	Diarrhea		Thailand	Decoction	Sairattanain, 2015
<i>S. grandiflora</i>	Bark	Diarrhea		Thailand	Chopped, ground with weaver ants (<i>Oecophylla</i> sp.), and taken orally	Suwanantawong, 2011
<i>S. grandiflora</i>	Bark and root	Dysentery		Thailand	Three to four pieces of bark or two roots of <i>Sesbania</i>	Suwanantawong, 2011

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
					<i>grandiflora</i> and two to three whole plant of <i>Phyllanthus amarus</i> soaked in water for 30 minutes before drinking the supernatant	
<i>S. grandiflora</i>	Stem bark	Diarrhea	Korbokae	Thailand	Ground and mixed with lime water	Thongdonair, 2003
<i>S. grandiflora</i>	Bark and leaves	Aphthous ulcers	Khae baan	Thailand		Humphanon et al., 2002
<i>S. grandiflora</i>	Bark and flower	Diarrhea and constipation	Khae Ban	Thailand		Niyomyat, 1999
<i>S. grandiflora</i>	Bark	Diarrhea and flatulence		Thailand		Vanichkul, 2008
<i>S. grandiflora</i>	Root bark	Diarrhea		Thailand	Ground or decocted	Pongthornpruek, 2011
<i>S. grandiflora</i>	Bark	Diarrhea		Thailand		Boontun, 2010
<i>S. grandiflora</i>	Bark	Diarrhea		Cambodia	Decoction	Chassagne et al., 2016
<i>S. grandiflora</i>	Bark	Diarrhea	Katirai	Philippines	Decoction	Abe & Ohtani, 2013
<i>S. grandiflora</i>	Bark	Diarrhea	Avisachettu	India		Padal et al., 2013

[illegible]

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
<i>S. sesban</i>	Leaves	Diabetes	Jayanti	India	Decoction	Tarafdar et al., 2015
<i>S. sesban</i>	Root	Diabetes	Muzimbandeya	Uganda		Tugume et al., 2016
Genitourinary System Disorders						
<i>S. grandiflora</i>	Roots	Contraceptive	Agasthi	India	Boiled and the decoction is taken orally twice a day for 3-4 days after the menstrual period	Mallick et al., 2014
<i>S. grandiflora</i>	Bark	Leucorrhea	Bakphul	India	50 grams of fresh bark extracted to make juice and applied to vaginal area	Adhikari et al., 2018
<i>S. grandiflora</i>	Flower	Light menstrual blood flow		India	Made on paste and taken orally	Balamurugan et al., 2017
<i>S. pachycarpa</i>	Whole plant	Urinary retention	More	Burkina Faso	Charred	Nadembega et al., 2011
<i>S. punicea</i>	Root	Menstrual disorders	Mokgabane	South Africa	One tin cup of root extract drunk. The extract prepared by boiling root in water for 20 minutes	Semenya et al., 2012
<i>S. sesban</i>	Leaves	Hydrocele	Jayantika, Jetrasin, Jayanti ^b	India	A poultice	Nadkarni, 1976

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
<i>S. sesban</i>	Seeds	Stimulates or increases menstrual flow/emmenagogue	Jayantika, Jetrasin, Jayanti ^b	India		Nadkarni, 1976
<i>S. sesban</i>	Seeds and bark	Excessive menstrual flow (menorrhagia)	Jayantika, Jetrasin, Jayanti ^b	India		Nadkarni, 1976
Ill-Defined Symptoms						
<i>S. sesban</i>	Root	Dizziness		East Africa	Drinking root drops	Haedi, 1964
Infections/ Infestations						
<i>S. bispinosa</i> [as <i>S. aculeata</i>]	Leaves and roots	Kidney infections	Kayu ambun	Indonesia	Decoction	Grosvenor et al., 1995
<i>S. grandiflora</i>	Stem bark	Fever	Korbokae	Thailand	Decoction	Thongdonair, 2003
<i>S. grandiflora</i>	Young shoot, young leaves, and flowers	Fever	Khae baan	Thailand		Chumnasiao, 2004
<i>S. grandiflora</i>	Young shoot, young leaves,	Fever	Khae dok khao, Khae dok daeng	Thailand		Ngamsiri, 2015

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
	and flowers					
<i>S. grandiflora</i>	Leaves	Fever during menstruation	Khae Ban	Thailand		Niyomyat, 1999
<i>S. grandiflora</i>	Fresh leaves	Fever		Thailand		Sairattanain, 2015
<i>S. grandiflora</i>	Flowers	Cold		Thailand		Vanichkul, 2008
<i>S. grandiflora</i>	Bark and leaves	Fever	Khae baan	Thailand		Humphanon et al., 2002
<i>S. grandiflora</i>	Leaves and flowers	Nasal catarrh	Bokful	Bangladesh	Taken orally	Islam et al., 2014
<i>S. grandiflora</i>	whole plant	Gonorrhea	Bock phool	Bangladesh	Apply the oil from the whole plant to the external male intromittent organ	Rahmatullah et al., 2012
<i>S. grandiflora</i>	Root	Catarrh	Agasta, Agasthio, Agath ^d	India	1–2 drops of root juice used with honey	Khory & Katrak, 1903
<i>S. grandiflora</i>	Leaves and flowers	Nasal catarrh	Agasta, Agasthio, Agath ^d	India	Leaf juice and flower juice blown into nostrils	Khory & Katrak, 1903
<i>S. grandiflora</i>	Bark	Scarlet fever	Agathi	India	Decoction	Vijayakumar et al., 2015
<i>S. grandiflora</i>	Bark	Malaria	Agse mara, Agasatibak	India	Infused and taken during the first stage of malaria	Rajasab & Isaq, 2004

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
<i>S. grandiflora</i>	Bark	Smallpox		India	Decoction used for bathing	Morvin Yabesh et al., 2014
<i>S. grandiflora</i>	Leaves	Sore throat		India	Leaf juice	Morvin Yabesh et al., 2014
<i>S. grandiflora</i>	Leaves	Fever	Avisa	India	A spoonful of its leaf juice is orally taken twice a day for two days	Padal et al., 2014
<i>S. grandiflora</i>	Leaves	Skin lice	Agasthi	India		Mallick et al., 2014
<i>S. grandiflora</i>	Flower	Hepatitis		India	Drink a cup of flower extract twice a day	Patil & Patil, 2011
<i>S. grandiflora</i>	Leaves and stem	Ailments related to HIV/AIDS	Ntatembwa, Muwoganyanja	Uganda		Lamorde et al., 2010
<i>S. javanica</i>	Roots	Malaria	Daəm snao	Cambodia		Martin, 1971
<i>S. microphylla</i>	Leaves	Malaria and febrile convulsion in children	Msenga, Mbondo	Tanzania	Decocted with the leaves of <i>Orthosiphon thymiflorus</i> [as <i>O. suffrutescens</i>] and <i>Solanum aculeastrum</i>	Moshi et al., 2012
<i>S. pachycarpa</i>	Root	Malaria	More	Burkina Faso	Macerated	Nadembega et al., 2011
<i>S. sesban</i>	Leaves	Fever	Theya	India	Macerated and orally taken	Chander et al., 2015

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
<i>S. sesban</i>	Leaves	Fever related to malaria	Janter	Pakistan	Infused and one cup of infusion drunk	Shah & Rahim, 2017
<i>S. sesban</i>	Root	Vermifuge		East Africa	Root juice drunk once a day for 1–3 days	Haedi, 1964
<i>S. sesban</i>	Leaves or roots	Syphilis	Umunyegenyege	Burundi	Decoction	Ngezahayo et al., 2015
<i>S. sesban</i>	Leaves or roots	Tooth decay	Umunyegenyege	Burundi	Brush teeth with the decoction	Ngezahayo et al., 2015
<i>S. sesban</i>	Leaves or roots	Pneumonia	Umunyegenyege	Burundi	Calcined	Ngezahayo et al., 2015
<i>S. sesban</i>	Leaves	Leprosy		Tanzania	Leaf powder mixed with castor oil	Chhabra et al., 1990
<i>S. sesban</i>	Leaves	Venereal diseases	Zuzuma	Tanzania	Pounded and soaked in cold or warm water	Maregesi et al., 2007
<i>S. sesban</i>	Flowers	Malaria		Uganda	Decoction	Namukobe et al., 2011
<i>S. sesban</i>	Leaves and fruits	Sore throat, gonorrhea, and syphilis		Sudan		Elegami et al., 2001
<i>S. sesban</i>	Whole plants	Febrile convulsions in children	Muzimbandegeya	Uganda	Infused and drunk	Ssegawa & Kasenene, 2007
<i>S. sesban</i> subsp. <i>punctata</i> [as <i>S. punctata</i>]	Aerial parts	Fever related to malaria		Madagascar	Inhaling or drinking a decoction	Rasoanaivo et al., 1992

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
Inflammation						
<i>S. grandiflora</i>	Fruits	Sinusitis	Agasemara, Agasta, Agastya ^a	India	Ripened fruits	Nadkarni, 1976
<i>S. sesban</i>	Leaves or roots	Sinusitis	Umunyegenyege	Burundi	Crushed and instilling the juice into the nose or drinking a decoction	Ngezahayo et al., 2015
Injuries						
<i>S. grandiflora</i>	Bark	Wounds	Khae Ban	Thailand		Niyomyat, 1999
<i>S. grandiflora</i>	Flowers	Hemorrhage	Khae Ban	Thailand		Niyomyat, 1999
<i>S. grandiflora</i>	Bark	Clean wounds and stop bleeding		Thailand	Decoction	Sairattanain, 2015
<i>S. grandiflora</i>	Leaves	Bruises		Thailand	Pounded finely, mixed with a little water and applied to bruises	Pongthornpruek, 2011
<i>S. sesban</i>	Leaves	Suppuration	Champai, Jayante, Karijinange ³	India	A poultice	Khory & Katrak, 1903
<i>S. sesban</i>	Leaves	Suppuration and abscesses	Jayantika, Jetrasin, Jayanti ^b	India	A poultice	Nadkarni, 1976
<i>S. grandiflora</i>	Leaves	Pus, abscesses, and suppuration		India	A poultice	Pushpangadan & Atal, 1986
<i>S. javanica</i>	Leaves	Abscesses	Sano, Sano kin dok	Thailand	Pounded with saltpeter and soft-prepared chalk	Ngamsiri, 2015

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
<i>S. sesban</i>	Seeds	Relieve the pain of scorpion stings	Champai, Jayante, Karijinange ³	India	Seed powder	Khory & Katrak, 1903
<i>S. sesban</i>	Roots	Relieve the pain of scorpion stings	Jayantika, Jetrasin, Jayanti ^b	India	Made in the form of a paste	Nadkarni, 1976
Mental Disorders						
<i>S. grandiflora</i>	Root and leaves	Mental disorders		India	The ash dissolved in water and the strained water drunk along with magical incantation	Pushpangadan & Atal, 1986
<i>S. grandiflora</i>	Seeds and flowers	Mental retardation	Chogache	India	Drink 20–25 grams of ground seeds and eat 10–20 flowers until recovery	Laddimath & Rao, 2016
Muscular-Skeletal System Disorders						
<i>S. sesban</i>	Leaves	Rheumatoid arthritis	Jayantika, Jetrasin, Jayanti ^b	India	A poultice	Nadkarni, 1976
Neoplasms						
<i>S. grandiflora</i> [as <i>Agati grandiflora</i>]	Fruits	Tumorous growth	Agasemara, Agasta, Agastya ^a	India	Ripened fruits	Nadkarni, 1976

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
<i>S. sesban</i>	Whole plant	Throat cancer, uterine cancer, and skin cancer	Omukhule, Olukhulila mbusi, and Lohori	Kenya	Drink half a glass of a concoction twice a day for three weeks; besides, the whole plant pounded and applied on skin	Ochwang'i et al., 2014
Nervous System Disorders						
<i>S. grandiflora</i>	Leaf	Epilepsy	Bock phool	Bangladesh	Four teaspoons of its fresh leaf juice mixed with black pepper powder (<i>Piper nigrum</i>) and taken twice a day for 15–20 days	Rahmatullah et al., 2012
<i>S. grandiflora</i>	Flowers	Migraine treatment	Agasthi	India	Flower juice injected into the nostrils	Mallick et al., 2014
<i>S. grandiflora</i>	Seeds	Epilepsy		India	Crushed, mixed with cow urine and drunk	Borah & Prasad, 2017
<i>S. sesban</i>	leaves	Epilepsy and madness in small children caused by headworm	Oyieko	Kenya	Pounded and breathed into noses	Geissler et al., 2002

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
Nutritional Disorders						
<i>S. grandiflora</i>	Stem bark	Merasmus	Korbokae	Thailand	Decoction	Thongdonair, 2003
Pain						
<i>S. grandiflora</i>	Roots	Toothache	Kae, Khae	Thailand	Sucked	Inta, 2008
<i>S. grandiflora</i>	Bark	Toothache		Thailand		Vanichkul, 2008
<i>S. grandiflora</i>	Bark	Toothache		Cambodia	Chewed	Chassagne et al., 2016
<i>S. grandiflora</i>	Leaves	Headache	Agathi	India	Leaf juice	Vijayakumar et al., 2015
<i>S. grandiflora</i>	Leaves and flowers	Headache	Bokful	Bangladesh	Taken orally	Islam et al., 2014
<i>S. grandiflora</i>	Leaves and flowers	Headache	Agasta, Agastio, Agath ^d	India	Leaf juice and flower juice blown into nostrils	Khory & Katrak, 1903
<i>S. grandiflora</i>	Leaves and flowers	Headache	Khae Ban	Thailand		Niyomyat, 1999
<i>S. grandiflora</i>	Flowers	Headache	Agse mara, Agasatibak	India		Rajasab & Isaq, 2004
<i>S. grandiflora</i>	Leaves and flowers	Headache	Agastya	India	Two drops of flower or leaf juice put into the nostrils twice a day	Sahani & Mall, 2013
<i>S. javanica</i> [as <i>S. paludosa</i>]	Leaves	Toothache	Kaattu agathi	India	A paste	Ignacimuthu et al., 2008

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
<i>S. sesban</i>		Headache		India		Chellappandian et al., 2012
<i>S. sesban</i>	Flowers	Headache	Rawsan	India	Fried with clarified butter before eating	Sikarwar & Kaushik, 1993
<i>S. virgata</i>	Leaves	Vesicle pain and kidney pain		Bolivia	Squeezed in water or decocted and the extract taken orally	Bourdy et al., 2004
Poisonings						
<i>S. grandiflora</i>	Fruits	Poisoning	Agasemara, Agasta, Agastya ^a	India		Nadkarni, 1976
<i>S. grandiflora</i>		Bites from cobras, vipers, kraits, and hump nosed vipers/anti-venom		Sri lanka		Dharmadasa et al., 2016
Pregnancy/Birth/Puerperium Disorders						
<i>S. grandiflora</i>	Leaves	Postnatal care	Turi	Indonesia	Used for Bakera which is a herbal steam bath	Zumsteg & Weckerle, 2007
<i>S. grandiflora</i>	Leaves	Postnatal care		Malaysia	Used in two formulations for postnatal care ^e	Jamal et al., 2011
<i>S. sesban</i>	Leaves and flowers	Induce labor		Uganda	Chewed	Hamill et al., 2000

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
Respiratory System Disorders						
<i>S. grandiflora</i>	Roots	Expectorant	Khae Ban	Thailand		Niyomyat, 1999
<i>S. grandiflora</i>	Roots	Expectorant	Agasta, Agastio, Agath ^d	India		Khory & Katrak, 1903
<i>S. grandiflora</i>	Roots	Expectorant	Agasemara, Agasta, Agastya ^a	India		Nadkarni, 1976
<i>S. grandiflora</i>	Leaves and flowers	Cough		India		Pullaiah et al., 2016
<i>S. grandiflora</i>	Flowers	Cough	Bock phool	Bangladesh	Two to three flowers fried in clarified butter and taken orally	Rahmatullah et al., 2012
<i>S. pachycarpa</i>	Roots	Cough	More	Burkina Faso	Macerated	Nadembega et al., 2011
<i>S. sesban</i>		Pulmonary diseases		India		Mutheeswaran et al., 2011
<i>S. sesban</i>	Leaves	Avian flu		Ethiopia	Crushed, homogenized in water and drunk	Wondimu et al., 2007
Sensory System Disorders						
<i>S. grandiflora</i>	Bark	Cool eyes	Agathi	India	Decoction	Vijayakumar et al., 2015
<i>S. grandiflora</i>	Flowers	Itching and irritating eyes		India	Flower juice	Pushpangadan & Atal, 1986
<i>S. grandiflora</i>	Flowers	An eye drop	Agse mara, Agasatibak	India	Flower juice	Rajasab & Isaq, 2004
<i>S. grandiflora</i>	Flowers	Improve eye sight	Agasthi	India		Mallick et al., 2014

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
<i>S. pachycarpa</i>	Root	Eye ailments	More	Burkina Faso	Macerated	Nadembega et al., 2011
Skin/Subcutaneous Cellular Tissue Disorders						
<i>S. grandiflora</i>	Root bark	Swelling	Bokful	Bangladesh	A paste	Islam et al., 2014
<i>S. grandiflora</i>	Roots	Painful swellings	Agasta, Agasthio, Agath ^d	India	Paste applied to affected areas	Khory & Katrak, 1903
<i>S. grandiflora</i>	Roots	Painful swellings	Agasemara, Agasta, Agastya ^a	India	Paste applied to affected areas	Nadkarni, 1976
<i>S. grandiflora</i>	Bark	Skin irritation	Agathi	India	Decoction	Vijayakumar et al., 2015
<i>S. grandiflora</i>	Stem bark	Pruritus	Tella sumintha	India	A paste	Padal et al., 2015
<i>S. grandiflora</i>	Bark	Pruritus	Bakphul	India	Bark juice	Adhikari et al., 2018
<i>S. grandiflora</i>	Stem bark	Pruritus	Avira	India		Padal & Sandhya, 2013
<i>S. grandiflora</i>	Leaves	Rashes		India	Leaf juice mixed with coconut milk	David & Sudarsanam, 2011
<i>S. grandiflora</i>	Leaves	Jaundice		India	Leaf extract	Datta et al., 2014
<i>S. grandiflora</i>	Flowers	Infected skin		India	Crushed and mixed with curd and cheese	Saikia et al., 2006
<i>S. grandiflora</i>	Fruits	Jaundice	Agasemara, Agasta, Agastya ^a	India		Nadkarni, 1976
<i>S. sesban</i>	Seeds and bark	Astringent	Champai, Jayante, Karijinange ³	India	Seeds and juice of bark	Khory & Katrak, 1903

Species	Used parts	Used for/as	Common names	Country or region	Modes of preparation and administration	Reference
<i>S. sesban</i>	Seeds and bark	Itch	Jayantika, Jetrasin, Jayanti ^b	India	An ointment	Nadkarni, 1976
<i>S. sesban</i>	Seeds and bark	Cutaneous eruptions	Jayantika, Jetrasin, Jayanti ^b	India	An ointment and bark juice taken orally	Nadkarni, 1976
<i>S. sesban</i>		Dermatological ailments		India		Mutheeswaran et al., 2011
Unspecified Medical Disorders						
<i>S. grandiflora</i>	Roots	Wasting disease drugs	Korbokae	Thailand	Decocted with other ingredients (which were unspecified)	Thongdonair, 2003
<i>S. grandiflora</i>	Leaves	Body cooling		India	Boiled and the decoction mixed with buttermilk	Ayyanar & Ignacimuthu, 2011
<i>S. grandiflora</i>		Reduce Pittam, Kapham, and induces Vayu ^f	Agasemara, Agasta, Agastya ^a	India		Nadkarni, 1976
<i>S. grandiflora</i>	Leaves	Strange in the knees		India		Sivasankari et al., 2013
<i>S. sesban</i>	Leaves	Chira - a disease with AIDS-like symptoms (Ndege, 2001)	Oyieko	Kenya	Pounded, mixed with water and taken orally.	Geissler et al., 2002
<i>S. sesban</i>				Uganda		Tabuti et al., 2012

^a See appendix 4 for other common names of *Sesbania grandiflora* cited by Nadkani (1976)

^b See appendix 4 for other common names of *Sesbania sesban* cited by Nadkani (1976)

^c See appendix 4 for other common names of *Sesbania sesban* cited by Khory & Katrak (1903)

^d See appendix 4 for other common names of *Sesbania grandiflora* cited by Khory & Katrak (1903)

^e See subcategory 'Pregnancy/Birth/Puerperium Disorders' for further information

^f Pittam, Kapham, and Vayu are the components of Tridoshas which correspond to three dynamic natural forces. Regarding Ayurveda, any ailments are caused by the imbalance in at least one of natural forces. Pittam is a combination of fire and water. Kapham is a combination of earth and water. Vayu is air.

5. Environmental uses

This category is broadly defined and covers uses that benefits the environment, including sustainable agriculture. Seven *Sesbania* species are used for shelter, reforestation, soil improvement, ornamentals, hedgeplants, windbreaks and for pollution controle.

Shade/Shelter. *Sesbania grandiflora* is used as a nurse or shade tree, particularly for black pepper, (Martin & Ruberté, (1975). In Malaysia *Sesbania grandiflora* is also planted for light-shade (Corner, 1940).

Revegetation. In Taiwan and Indonesia *Sesbania grandiflora* is used for reforestation of eroded slopes (Rachie, 1979).

Soil improvement. A study of *Sesbania bispinosa* [as *S. aculeata*], *Sesbania rostrata*, and *Sesbania speciosa* as ‘biofertilizers’ for rice showed that *Sesbania rostrata* which has both root and stem nodules had the highest nitrogen content; it had twice as much nitrogen content as *Sesbania bispinosa* and *Sesbania speciosa*. Regarding the micronutrients, *Sesbania rostrata* contained the highest amount of manganese, zinc, and copper whereas the highest iron content was found in *Sesbania bispinosa*. Because of its high nitrogen and micronutrient content, *Sesbania rostrata* should be considered as a good biofertilizer (Kalidurai & Kannaiyan, 1991). Biofertilizers are substances that contain microorganisms that increase plant growth (Reddy & Saravanan, 2013) whereas the fertilizer made of plants is ‘green manure’ (www.oxfordlearnersdictionaries.com). *Sesbania cannabina* is used as a green manure on oceanic Islands (George et al., 1994) and in Fiji, (Smith, 1985). In West Bengal of India *Sesbania cannabina* is not only used as green manure for coconut, rice, sugarcane and wheat, but it is also used to reclaim soil from salinity and alkalinity (Datta & Banerjee, 1978). *Sesbania grandiflora* is grown for its value as a green manure crop (Martin & Ruberté, 1975) and its leaves make a thick mulch which adds nutrients to the soil and fertilizes other crops (Rachie, 1979). In Southeast Asia *Sesbania grandiflora* is planted to provide green manure along rice paddies. In Java 55 tons per hectare of green materials were obtained in 6–7 months from *S. grandiflora* (Rachie, 1979). In Arizona *Sesbania herbacea* [as *S. macrocarpa*] is planted as a soil improvement crop in the southwest and a cover crop in citrus orchards (Kearney & Peebles, 1960). *Sesbania sesban* [as *S. aegyptiaca*] is used as a green manure crop for *Palaquium gutta* (Hook.) Burck at Tjipetir of Indonesia. *Palaquium gutta* is used to produce gutta-percha latex (Williams, 1964). *Sesbania speciosa* has been grown as a green manure in south India (Verdcourt, 1979).

Ornamentals. In Southeast Asia the large flowers and long pods of *Sesbania grandiflora* make a striking ornamental (Lecomte et al., 1912; Rachie, 1979). *Sesbania grandiflora* is also planted as an ornamental in India (Brandis, 1921), Christmas Island of Australia (George et al., 1994) and Fiji (Smith, 1985). In Thailand *Sesbania grandiflora* is common in homegardens as an ornamental that also serves as a source of food and medicine (personal observation). In North America *Sesbania punicea* is planted as an ornamental (Farruggia, 2009). In Hawaii *Sesbania tomentosa* is planted as an ornamental (Hillebrand, 1965).

Boundaries/Barriers/Supports. In Sukhothai province of Thailand the stem of *Sesbania grandiflora* is used for growing Jew’s ear mushroom (*Auricularia auricula-judae*) in Khirimat district (Ngamsiri, 2015). In Southeast Asia and India *Sesbania grandiflora* is planted as a living

fence and a supporter for pepper (*Piper* sp.), betel (*Piper betle*), and vanilla (we presume from *Vanilla planifolia*) (Roxburgh, 1874; Lecomte et al., 1912; Brandis, 1921; Rachie, 1979; Rajasab & Isaq, 2004). *Sesbania grandiflora* is also used as living fences in Bontoc region of the Philippines (Bodner & Gereau, 1988) and as support for pepper in Malaysia (Ridley, 1922). Besides *Sesbania grandiflora*, *Sesbania sesban* [as *S. aegyptiaca*] is also used to make hedges and fences in Southeast Asia (Lecomte et al., 1912). In Delhi of India *Sesbania sesban* and *S. sesban* var. *bicolor* are cultivated for shade and also used as hedges (Maheshwari, 1963). *Sesbania sesban* is cultivated to be used as a living fence in Sebata-Awas district in Ethiopia (Mekonen et al., 2015).

Windbreaks. *Sesbania cannabina* is proposed as a windbreak in Iraq (Townsend & Guest, 1974).

Pollution control. According to a study of phytosequestration of metals in selected plants, *Sesbania cannabina* was the highest accumulator among terrestrial plants. However, because its translocation factors (TF) were low ($TF < 1$), except for Hg ($TF = 3$), it was not recommended to be used for heavy metal extraction. The translocation factor is a ratio of metal concentration in shoots and roots; if the TF in a plant is high, then the plant has high potential for extracting metals (Ahmad et al., 2011). Although *Sesbania sesban* has potential to remove several metals from the soil, it is less useful for uptake of cadmium because of its low translocation factor (Eller & Brix, 2016). *Sesbania sesban* could be used to treat wastewaters because it removes nitrogen and phosphorus from the wastewaters in the constructed wetland system (Dan et al., 2011).

Glutathione, non-protein thiols, superoxide dismutase, ascorbate peroxidase, and glutathione reductase affected mercury (Hg) tolerance. The amounts of these substances in a cell culture of *Sesbania drummondii* increased when the Hg content increased. However, they decreased when the cultures were treated by 50 μ M Hg (Israr & Sahi, 2006). *Sesbania drummondii* seedlings could accumulate lead (Pb). The Pb combined with phosphorus to form lead phosphate and accumulated in the cell wall of cells around root stele, root cortex under the epidermis, root epidermal surface, and pith (Barlow et al., 2000). *Sesbania virgata* reduced mobility of zinc, chromium, and copper in soil through absorption by roots so *Sesbania virgata* could be used as a phytostabilizer (Branzini et al., 2012). Activities of ascorbate peroxidase, guaiacol peroxidase, catalase, superoxide dismutase, and glutathione content increased in *Sesbania drummondii* seedlings grown in media containing 500 mg/L Pb (Ruley et al., 2004).

Unspecified Environmental Uses. A study of the solar energy conversion efficiency of TiO₂ nanorods which were sensitized by flowers of *Sesbania grandiflora*, leaves of *Camellia sinensis*, and roots of *Rubia tinctorum* demonstrated that although cyaniding 3-O-glucoside in *S. grandiflora* can increase the performance of TiO₂ nanorods, it had a very low power conversion efficiency of 0.65% (Akila et al., 2016).

6. Materials

Six different species of *Sesbania* have served to produce a number of utensils and other material such as fibers for textiles, fibers for fishing lines, wood for light construction, gum and textile dyes.

Fibers. *Sesbania bispinosa* [as *S. aculeata*] provides good textile fiber (Lecomte et al., 1912). Fiber of *Sesbania bispinosa* [as *S. aculeata*] are 0.96 mm long and 0.02 mm wide. Fiber density, fiber wall thickness, and fiber slenderness were 0.3 b/cm³, 1.4 μ m, and 48. The chemical compositions

of fiber were 2.6% resin, 22% lignin, 5% acetyl, 5% uronic acid, 0.5% ash, 0.2% silica, 0.9% galactose, 70% glucose, 3% mannose, 0.6% arabinose, 26% xylose, 46% cellulose, 4% glucomannan, and 27% glucuronoxylan acetate. The morphological, physical, and chemical features of *Sesbania bispinosa* fiber were similar to those of birch fiber except for silica which was not found in birch fiber (van Nao, 1983). *Sesbania bispinosa* [as *S. aculeata*] could be used for nonwoven fabric production. *Sesbania bispinosa* soaked in water for 15 days provided the best fiber bundle strength, fiber strength, and fiber fineness (19 g/tex, 5 g/denier (denier equals the mass in g of 9000 m of the fiber), and 39 denier, respectively) compared to those soaking in water for 22 days and 30 days. Potassium hydroxide and hydrogen peroxide could be used as scouring agent and bleaching agent for the production using the needle punching method (Singh & Rani, 2013). *Sesbania cannabina* [as *S. cannabina* var. *floribunda*] is used as hemp to make nets because of its moisture resistance in Vietnam (Lecomte et al., 1912), it is cultivated in Bengal for bark fibers (Roxburgh, 1874), used for producing fishing lines and nets in Fiji (Smith, 1985), and cultivated for fiber on oceanic Islands (George et al., 1994). In East Java *Sesbania grandiflora* has been used as a paper-pulp source, but the bark has to be removed because it contains gum and resin. Moreover, it was discovered by Australian workers that *Sesbania grandiflora* and kenaf [we presume *Hibiscus cannabinus*] together are good for pulping because *Sesbania grandiflora* improves the drainage rate of kenaf pulp (Rachie, 1979). Fiber length of *Sesbania grandiflora* was 1 mm (Food Agriculture Organization of the United Nations. Forestry Industries Division, 1980). In Arizona *Sesbania herbacea* [as *S. macrocarpa*] is used by Quechan to produce threads for making nets and fish lines (Kearney & Peebles, 1960). In Cambodia stems of *Sesbania javanica* are used to make fishing lines (Martin, 1971).

Wood. Wood of *Sesbania sesban* [as *S. aegyptiaca*] is white, soft, light and fibrous and used for making childrens' toys in Myanmar (Kurz, 1877). *Sesbania grandiflora* is used for making house-post in India (Brandis, 1921). In the Mbulu district of Tanzania *Sesbania keniensis* stems are used to build houses and huts (Gillett, 1963).

Gum. In the Philippines a clear gum of *Sesbania grandiflora* is used as a gum arabic substitute (Dasanayake & Fosberg, 1991).

Tannin/Dyestuffs. In India the ethanolic extracts of *Sesbania bispinosa* [as *S. aculeata*] leaves and stems yielded the different shades of green when they were used to dye cotton (Swami et al., 2012a) whereas the different shades of beige, yellow and brown were obtained on silk and polyester-cotton blend dyed with the aqueous extracts of leaves and tender stems of *Sesbania bispinosa* (Swami et al., 2012b). In Thailand the aqueous extracts of *Sesbania grandiflora* bark provided brown-reddish shade on cotton (Tommajung, 2003).

Unspecified materials. In the Deccan of India *Sesbania sesban* is cultivated and used as "a bamboo substitute", but details about how it is used were not provided (Drury, 1978). In Africa *Sesbania keniensis* leaves, which produce a lather when they are rubbed, are used as a soap substitute (Gillett, 1963).

7. Fuel

All plants can burn, including all *Sesbania* species, and some are good for fuel or firewood. We have found a few references to this kind of use of two very common species of *Sesbania*, but these uses appear of no great economic importance.

Fuelwood. In Indonesia *Sesbania grandiflora* can be found along roadsides on dikes between rice fields and around villages and houses. It is harvested in 5-year rotations, particularly for firewood (Rachie, 1979). *Sesbania grandiflora* is also used as firewood in India (Roxburgh, 1874; Brandis, 1921). Wood of *Sesbania sesban* is used to make charcoal for gunpowder production in Southeast Asia (Kurz, 1877; Lecomte et al., 1912), India (Roxburgh, 1874; Brandis, 1921; Phillips, 1922; Maheshwari, 1963; Drury, 1978) and Hawaii (Wagner et al., 1999).

8. Social uses

Many plants are used in rituals or in other social contexts, but this does not appear to be very important for species of *Sesbania*, since we found only a couple of references mentioning this use category for any species of the genus.

In many Tamil villages in India people eat a combination of bitter gourd, some non-native pulses, and *Sesbania* leaves without cooking during the village religious festivals after hoisting the temple flags (Pullaiah et al., 2016). In Caste communities of India *Sesbania grandiflora* is used with magical or religious incantations to exorcise bad spirits from the patients with serious diseases (Pushpangadan & Atal, 1986).

Other economic importance

Some of the references we found to *Sesbania* could not be placed in the system of categories that we used (Cook, 1995). They are here listed as miscellaneous information about the economic importance of nine *Sesbania* species.

Weeds. The most common *Sesbania* weed in many tropical countries is *Sesbania bispinosa* (Phillips, 1922; Rachie, 1979; Kamoshita et al., 2014). *Sesbania cannabina* is a weed of irrigated rice-fields in Australia (Burbidge, 1965). *Sesbania concolor* is a weed in west Pakistan and west Punjab of India (Gillett, 1963). *Sesbania drummondii* is a weed in cropland in USA (Eastin, 1984). *Sesbania herbacea* [as *S. exaltata*] is a weed in soybean fields in Mississippi of USA (Rankins et al., 2005). *Sesbania leptocarpa* [as *S. arabica*] is a weed in central Sudan (Braun et al., 1991). *Sesbania punicea* is a weed in pastures in USA (Cuda et al., 1996). *Sesbania speciosa* is a weed in pasture fields at Popondetta of Papua New Guinea (Verdcourt, 1979).

Sacrificial host. On the Indonesian island of Timor *Sesbania grandiflora* is planted as a host for parasitic tree - sandalwood *Santalum* (Rachie, 1979).

Pest host. In Georgia in the USA *Sesbania punicea* was found to be a host of green stink bug (*Chinavia hilaris*) that is a pest of cotton (*Gossypium hirsutum*). Its fruits were food for nymphs and adults of green stink bug. The nymphs of green stink bug also developed on *Sesbania punicea* (Tillman, 2015).

Diversity of used *Sesbania* species

Twenty-two species of *Sesbania* have been used in eight use categories (Fig. 2). *Sesbania grandiflora* is used in all categories, and it is the most well-known *Sesbania* which is distributed and cultivated in many countries in subtropical and tropical regions. *Sesbania sesban* is the second most used species and has been used as a traditional medicine in several ethnic groups and it has also been cultivated for medicinal uses. *Sesbania javanica* is the third ranking species and has been used as food and cultivated in several Southeast Asian countries. Surprisingly, *Sesbania bispinosa* which is pantropical and subtropical has a few uses, possibly because of its small flowers compared to those of *S. grandiflora* and *S. javanica*. The small flowers make it un-interesting as a food in most countries. Moreover, *Sesbania bispinosa* has prickles which is an obstacle for using it and it is considered to be a common weed in many countries. The few use records for several *Sesbania* species may be because of their limited geographic distribution, such as *Sesbania tomentosa* which occurs only in Hawaii and Mexico. Also local people may have better alternative species to be used, which may be the case for *Sesbania sericea* which is pantropical and subtropical had only two use records. When other *Sesbania* species, such as *S. grandiflora* or *S. sesban*, appear in the same area they may be more convenient for local people to use.

Fig. 2 Recorded number of uses for 22 *Sesbania* species.

Microorganisms related to use of *Sesbania* species

We found evidence of five *Sesbania* species that were used to test antimicrobial activities against 27 species of microorganisms: 22 species of bacteria and five species of fungi (Appendix 2). Regarding bacteria, we did not find different activities relative to different gram stain bacteria. For example, *Sesbania sesban* had positive activity on *Bacillus cereus* (gram-positive bacteria) and *Klebsiella pneumoniae* (gram-negative bacteria), but it had negative activities on *Enterococcus faecalis* (gram-positive bacteria) and *Proteus vulgaris* (gram-negative bacteria). Although *Sesbania grandiflora* and *S. sesban* are used as traditional medicine to treat diarrhea, it could be because of their effect on some bacterial species such as *Bacillus cereus*, but on the other hand they would not have any effect on diarrhea caused by *Escherichia coli* since they could not inhibit *E. coli*. This knowledge should be passed on to local people because they should know that their traditional medicine cannot always be used to treat the same ailments. *Sesbania punicea* should be promoted to treat typhoid and paratyphoid, especially in remote areas where the species are found, because it could inhibit *Salmonella enterica* subsp. *enterica* serovar Paratyphi B and *Salmonella typhi*. Different *Sesbania* species had different effect on the same bacteria. For example, *Sesbania bispinosa* and *S. sesban* inhibited *Staphylococcus aureus* whereas *S. macrantha* and *S. punicea* did not. The different varieties of *Sesbania* species had different activities on the same bacteria species. For example, *Sesbania sesban* inhibited *Staphylococcus aureus* and *Candida albicans*, but *Sesbania sesban* var. *nubica* did not. The previous content showed the importance of uses of exact *Sesbania* species or varieties for the most effective in medicinal uses. *Sesbania grandiflora* had both positive and negative effect on some species of microorganisms such as *Bacillus subtilis*, *Pseudomonas aeruginosa* and *Candida albicans*. The different activities depended on different methods used in the experiment. For example, ethanolic leaf extract of *S. grandiflora* did not inhibit *Pseudomonas aeruginosa* whereas the nanosized leaf powder did. Besides being used to test antimicrobial activities, *Sesbania grandiflora* is used for growing Jew's ear mushroom (*Auricularia auricula-judae*).

Animals related to use of *Sesbania* species

Seventeen animals are related to the uses of 14 *Sesbania* species in this review (Appendix 3). Whereas 16 of animals are positively or negatively affected by *Sesbania*, the ant is the only animal that is not affected by *Sesbania*. It is related to *Sesbania* for its use along with *S. grandiflora* for diarrhea treatment. Of the remaining 13 *Sesbania* species, eight had advantages for animals; however, *S. punicea* has a disadvantage for human because it is a pest host whereas other seven species are only used as fodder and *S. greenwayi* and *S. keniensis* are not used for domestic animals. Two *Sesbania* species (*S. drummondii*, *S. vesicaria*) have only disadvantages for animals which may die from ingesting their seeds. Three species (*S. bispinosa*, *S. grandiflora*, *S. sesban*) have both advantages and disadvantages for animals. *Sesbania bispinosa* is used as a medicine in cattle and sheep, but it has negative effect when ingested by carps and tilapias. *Sesbania grandiflora* and *S. sesban* have benefits for their uses as fodder and veterinary medicines, but the disadvantages of them for animals have benefits to human because they are used to kill parasitic animals. Besides *Sesbania grandiflora* and *S. sesban*, *S. macrantha* is used to kill parasitic animals in livestock. As some *Sesbania* species can kill animals, the amount of *Sesbania* should be considered when it is used for animal feed.

Common names of *Sesbania* species

We found 113 common names for eight *Sesbania* species (Appendix 4) out of the total of 22 species for which we found evidence of uses. Possibly the eight species are more well-known to local people than the other species or the common names of some species were not recorded by the authors of the references in which their uses were mentioned. *Sesbania grandiflora* has 64 and *S. sesban* has 35 common names, respectively. These two species have been widely used, especially *S. grandiflora* which is cultivated as an ornamental and a food plants in many countries. The same common names — Akatti, Kuturu murunga and Turi — are used in different countries (Akatti and Kuturu murunga are used in India and Sri Lanka whereas Turi is used in Malaysia and Indonesia). The same common name in Malaysia and Indonesia may be because these countries are neighbors and the same ethnic groups are found in them. For example, Malay is an ethnic group found in Malaysia and Indonesia. More than one common name is applied to one species in some countries. For example, 35 common names are applied to *Sesbania grandiflora*, 27 common names are applied to *S. sesban* in India and 12 common names are applied to *S. grandiflora* in Thailand. The reason may be because these species are used by several ethnic groups in the countries. Some common names are similar to one another, such as Bock phool and Bokful or Toori and Turi. This may be because of the variation of spelling by authors or the different pronunciations by local people.

Chemical compounds of economic *Sesbania* species

We found mention of 60 chemical compounds, including macromolecules and minerals, relative to the uses of 11 *Sesbania* species (Appendix 5). Seventeen compounds had medicinal properties. Some of them, such as saponin and stigmasterol, have potential in treatments in more than one medicinal use category; saponin can be used for inflammation and neoplasm and stigmasterol can be used for endocrine system disorders and muscular-skeletal system disorders. Some compounds, such as sesbanimide, were not detected in every species. Powell et al. (1990) reported that sesbanimide was not be detected in *Sesbania bispinosa*, *S. emerus*, *S. grandiflora*, *S. herbacea*, *S. sesban* and *S. speciosa*. This means that only some *Sesbania* species have the potential to treat certain disorders. Besides, if some species are used as traditional medicines to treat a disorders, but the chemicals which have the potential for treatment were not be detected, it may be because there are other compounds that remain undetected in those species. For example, *Sesbania grandiflora* has been used as a traditional medicine to treat neoplasm, but some research (Jain & Jain, 2011; Mackeen et al., 1997; Roy et al., 2013) showed that *Sesbania grandiflora* had potential for neoplasm treatment. The specific compounds for antitumor or anticancer properties of *S. grandiflora* have not been reported. Although tannin found in *S. grandiflora* has antitumor properties, the studies of compounds which show the activity should be conducted to prove that only tannin or other compounds have this property. Moreover, the activities of *Sesbania* species used as traditional medicine for some disorders should be investigated. For example, *Sesbania grandiflora* are used as an antidote in India and Sri Lanka, but we found no evidence of experiments that showed that it had antidote properties. The study of antidote properties of *Sesbania grandiflora* will not only have direct benefits for people who live in remote areas, but it will also have benefits for the pharmaceutical industry. Besides chemical compounds with medicinal properties, we found some evidence of other compounds with nutritional properties, such as minerals and vitamins, which are important because they help people, especially in remote area, to stay healthy.

Geographic distribution of uses of *Sesbania* species

Sesbania species have been used in tropical and subtropical regions (Fig. 3 and Appendix 6). Some countries, such as India and Thailand, have more use records than other countries whereas some tropical countries, such as Laos, Nigeria, Congo, Peru and Guatemala, have no use records. There are several explanations for this. Some countries such as India have many local journals and maybe 2000 ethnic groups which may make Indian ethnobotanists and economic botanists keen to study traditional uses of plants. Countries without information about traditional uses of *Sesbania* possibly publish their research in their own languages and the journals may not appear in the international search machines. The same reason can be used to explain why there were several records from Thailand in this review. Another reasons why some countries do not have records is that some literature cited regions, and not specific countries, as the area of *Sesbania* uses. In USA *Sesbania* has been used for environmental uses (Figure 3), materials, and fuel whereas in Australia *Sesbania* has been used for environmental purposes. *Sesbania* was recorded to be used in a few publications in two states (Arizona and Hawaii) in the USA whereas it was recorded to be used in one publication in Christmas Island??? of Australia. Some countries may not use *Sesbania* even if the genus occurs in them. This explanation came up while we were on fieldwork in Thailand. According personal observation, *Sesbania javanica* distributes in every part of Thailand; however, most of native people living in northern part of Thailand did not consume this species and they did not know that it is edible.

Fig. 3 Countries where *Sesbania* used in each of the eight categories mentioned above. **a** Human food. **b** Animal food. **c** Poisons. **d** Medicines. **e** Environmental uses. **f** Materials. **g** Fuels. **h** Social uses.

Conclusion

Twenty-two *Sesbania* species have been used in eight categories. *Sesbania grandiflora* is the most commonly used species in tropical and subtropical regions. *Sesbania concolor* and *Sesbania leptocarpa* were recorded as weeds without any uses whereas other weeds such as *Sesbania cannabina* are used in some categories.

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APPENDIX 1

Alphabetical listing of all scientific names of plants mentioned in the review of the economic importance of *Sesbania* species. For each name the author is provided. The family of each species is listed following The Plant List (<http://www.theplantlist.org/>).

Plant species	Family	Page
<i>Acorus calamus</i> L.	Acoraceae	
<i>Aesculus pavia</i> L.	Sapindaceae	
<i>Agati grandiflora</i> (L.) Desv. (= <i>Sesbania grandiflora</i>)	Fabaceae	
<i>Alyxia stellata</i> Roem. & Schult.	Apocynaceae	
<i>Arabidopsis thaliana</i> (L.) Heynh.	Brassicaceae	
<i>Brassica oleracea</i> L.	Brassicaceae	
<i>Brassica oleracea</i> var. <i>capitata</i> L. (= <i>B. oleracea</i>)	Brassicaceae	
<i>Camellia sinensis</i> (L.) Kuntze	Theaceae	
<i>Centella asiatica</i> (L.) Urb.	Apiaceae	
<i>Cinnamomum zeylanicum</i> Blume	Lauraceae	
<i>Crateva religiosa</i> G.Forst.	Capparaceae	
<i>Cucumis sativus</i> L.	Cucurbitaceae	
<i>Datura stramonium</i> L.	Solanaceae	
<i>Eugenia aromatica</i> Kuntze	Myrtaceae	
<i>Foeniculum vulgare</i> Mill.	Apiaceae	
<i>Glottidium vesicarium</i> (Jacq.) R.M.Harper (= <i>Sesbania vesicaria</i>)	Fabaceae	
<i>Gossypium hirsutum</i> L.	Malvaceae	
<i>Hibiscus cannabinus</i> L.	Malvaceae	
<i>Illicium tenuifolium</i> (Ridl.) A.C.Sm.	Achisandraceae	
<i>Lactuca sativa</i> L.	Asteraceae	
<i>Leucaena leucocephala</i> (Lam.) de Wit	Fabaceae	
<i>Nigella sativa</i> L.	Ranunculaceae	
<i>Orthosiphon suffrutescens</i> (Thonn.) J.K.Morton (= <i>O. thymiflorus</i>)	Lamiaceae	
<i>Orthosiphon thymiflorus</i> (Roth) Sleesen	Lamiaceae	
<i>Oryza sativa</i> L.	Poaceae	
<i>Palaquium gutta</i> (Hook.) Burck	Sapotaceae	
<i>Peucedanum japonicum</i> Thunb.	Apiaceae	
<i>Piper</i> sp.	Piperaceae	
<i>Piper betle</i> L.	Piperaceae	
<i>Piper cubeba</i> Bojer	Piperaceae	
<i>Piper nigrum</i> Beyr. ex Kunth	Piperaceae	
<i>Phyllanthus amarus</i> Schumach. & Thonn.	Euphorbiaceae	
<i>Rheum officinale</i> Baill.	Polygonaceae	
<i>Rubia tinctorum</i> L.	Rubiaceae	
<i>Sesbania aculeata</i> (Schreb.) Pers. (= <i>S. bispinosa</i>)	Fabaceae	
<i>Sesbania aegyptiaca</i> Poir. (= <i>S. sesban</i>)	Fabaceae	
<i>Sesbania arabica</i> Steud. (= <i>S. leptocarpa</i>)	Fabaceae	

Plant species	Family	Page
<i>Sesbania bispinosa</i> (Jacq.) W. Wight	Fabaceae	
<i>Sesbania cannabina</i> (Retz.) Pers.	Fabaceae	
<i>Sesbania cannabina</i> var. <i>floribunda</i> Gagnep. (= <i>S. cannabina</i>)	Fabaceae	
<i>Sesbania concolor</i> J.B.Gillett	Fabaceae	
<i>Sesbania drummondii</i> (Rydb.) Cory	Fabaceae	
<i>Sesbania emerus</i> (Aubl.) Urb.	Fabaceae	
<i>Sesbania exaltata</i> (Raf.) Cory (= <i>S. herbacea</i>)	Fabaceae	
<i>Sesbania grandiflora</i> (L.) Pers.	Fabaceae	
<i>Sesbania greenwayi</i> J.B.Gillett	Fabaceae	
<i>Sesbania herbacea</i> (Mill.) McVaugh	Fabaceae	
<i>Sesbania hirtistyla</i> J.B.Gillett	Fabaceae	
<i>Sesbania javanica</i> Miq.	Fabaceae	
<i>Sesbania keniensis</i> J.B.Gillett	Fabaceae	
<i>Sesbania leptocarpa</i> DC.	Fabaceae	
<i>Sesbania longifolia</i> DC.	Fabaceae	
<i>Sesbania macrantha</i> E.Phillips & Hutch.	Fabaceae	
<i>Sesbania macrocarpa</i> Raf. (= <i>S. herbacea</i>)	Fabaceae	
<i>Sesbania microphylla</i> E.Phillips & Hutch.	Fabaceae	
<i>Sesbania pachycarpa</i> DC.	Fabaceae	
<i>Sesbania paludosa</i> Prain (= <i>S. javanica</i>)	Fabaceae	
<i>Sesbania pubescens</i> DC. (= <i>S. sericea</i>)	Fabaceae	
<i>Sesbania punctata</i> DC. (= <i>S. sesban</i> subsp. <i>punctata</i>)	Fabaceae	
<i>Sesbania punicea</i> (Cav.) Benth.	Fabaceae	
<i>Sesbania quadrata</i> J.B.Gillett	Fabaceae	
<i>Sesbania rostrata</i> Bremek. & Oberm.	Fabaceae	
<i>Sesbania sericea</i> (Willd.) Link	Fabaceae	
<i>Sesbania sesban</i> (L.) Merr.	Fabaceae	
<i>Sesbania sesban</i> var. <i>bicolor</i> (Wight & Arn.) F.W.Andrews	Fabaceae	
<i>Sesbania sesban</i> var. <i>nubica</i> Chiov.	Fabaceae	
<i>Sesbania sesban</i> subsp. <i>punctata</i> (DC.) J.B.Gillett	Fabaceae	
<i>Sesbania somalensis</i> J.B.Gillett	Fabaceae	
<i>Sesbania speciosa</i> Taub.	Fabaceae	
<i>Sesbania tetraptera</i> Hochst. ex Baker	Fabaceae	
<i>Sesbania tomentosa</i> Hook. & Arn.	Fabaceae	
<i>Sesbania vesicaria</i> (Jacq.) Elliot	Fabaceae	
<i>Sesbania virgata</i> (Cav.) Pers.	Fabaceae	
<i>Solanum aculeastrum</i> Dunal	Solanaceae	
<i>Vanilla planifolia</i> Jacks. ex Andrews	Orchidaceae	
<i>Zingiber cassumunar</i> Roxb.	Zingiberaceae	

APPENDIX 2

Alphabetical listing of all scientific names of microorganisms and fungi mentioned in the review of the economic importance of *Sesbania* species. For each name the author is provided. The family of each species is listed following The Plant List (<http://www.theplantlist.org/>).

Microorganism species	Family	Related <i>Sesbania</i> species	Use Categories	Page
Bacteria				
<i>Bacillus cereus</i> Frankland & Frankland	Bacillaceae	<i>S. sesban</i> ⁺	Infections	
<i>Bacillus subtilis</i> (Ehrenberg) Cohn	Bacillaceae	<i>S. grandiflora</i> ^{+/-} , <i>S. macrantha</i> ⁻ , <i>S. sesban</i> var. <i>nubica</i> ⁻	Infections	
<i>Enterococcus faecalis</i> (Andrewes and Horder) Schleifer and Kilpper-Balz	Enterococcaceae	<i>S. sesban</i> ⁻	Infections	
<i>Escherichia coli</i> (Migula) Castellani & Chalmers	Enterobacteriaceae	<i>S. bispinosa</i> ⁻ , <i>S. grandiflora</i> ^{+/-} , <i>S. punicea</i> ⁻ , <i>S. sesban</i> ⁻	Infections	
<i>Klebsiella oxytoca</i> (Flügge) Lautrop	Enterobacteriaceae	<i>S. sesban</i> ⁻	Infections	
<i>Klebsiella pneumoniae</i> (Schroeter) Trevisan	Enterobacteriaceae	<i>S. sesban</i> ⁺	Infections	
<i>Mycobacterium smegmatis</i> (Trevisan) Lehmann & Neumann	Mycobacteriaceae	<i>S. macrantha</i> ⁻ , <i>S. sesban</i> var. <i>nubica</i> ⁻	Infections	
<i>Mycobacterium tuberculosis</i> (Zopf) Lehmann & Neumann	Mycobacteriaceae	<i>S. grandiflora</i> ⁺	Infections	
<i>Neisseria gonorrhea</i> (Zopf) Trevisan	Neisseriaceae	<i>S. macrantha</i> ⁺ , <i>S. sesban</i> ⁺	Infections	
<i>Neisseria meningitides</i> (Albrecht & Ghon) Murray	Neisseriaceae	<i>S. macrantha</i> ⁺ , <i>S. sesban</i> ⁺	Infections	
<i>Proteus vulgaris</i> Hauser	Enterobacteriaceae	<i>S. sesban</i> ⁻	Infections	
<i>Pseudomonas aeruginosa</i> (Schroeter) Migula	Pseudomonadaceae	<i>S. grandiflora</i> ^{+/-} , <i>S. macrantha</i> ⁻ , <i>S. sesban</i> ⁻ ,	Infections	

Microorganism species	Family	Related <i>Sesbania</i> species	Use Categories	Page
		<i>S. sesban</i> var. <i>nubica</i> ⁻		
<i>Salmonella enterica</i> subsp. <i>enterica</i> serovar Gallinarum	Enterobacteriaceae	<i>S. macrantha</i> ⁻ , <i>S. sesban</i> var. <i>nubica</i> ⁻	Infections	
<i>Salmonella gallinarum</i> [= <i>Salmonella enterica</i> subsp. <i>enterica</i> serovar Gallinarum]	Enterobacteriaceae	<i>S. macrantha</i> ⁻ , <i>S. sesban</i> var. <i>nubica</i> ⁻	Infections	
<i>Salmonella enterica</i> subsp. <i>enterica</i> serovar Paratyphi B	Enterobacteriaceae	<i>S. punicea</i> ⁺	Infections	
<i>Salmonella paratyphi</i> B [= <i>Salmonella enterica</i> subsp. <i>enterica</i> serovar Paratyphi B]	Enterobacteriaceae	<i>S. punicea</i> ⁺	Infections	
<i>Salmonella typhi</i> (Schroeter) Warren & Scott	Enterobacteriaceae	<i>S. grandiflora</i> ⁺ , <i>S. punicea</i> ⁺	Infections	
<i>Salmonella typhimurium</i> (Loeffler) Castellani & Chalmers	Enterobacteriaceae	<i>S. sesban</i> ⁺	Infections	
<i>Shigella flexneri</i> Castellani & Chalmers	Enterobacteriaceae	<i>S. punicea</i> ⁺	Infections	
<i>Staphylococcus aureus</i> Rosenbach	Staphylococcaceae	<i>S. bispinosa</i> ⁺ , <i>S. grandiflora</i> ^{+/-} , <i>S. punicea</i> ⁻ , <i>S. macrantha</i> ⁻ , <i>S. sesban</i> ⁺ , <i>S. sesban</i> var. <i>nubica</i> ⁻	Infections	
<i>Staphylococcus saprophyticus</i> (Fairbrother) Shaw & al.	Staphylococcaceae	<i>S. sesban</i> ⁺	Infections	
<i>Streptococcus agalactiae</i> Lehmann & Neumann	Streptococcaceae	<i>S. punicea</i> ⁺	Infections	
<i>Streptococcus mutans</i> Clarke	Streptococcaceae	<i>S. punicea</i> ⁻	Infections	
<i>Streptococcus pyogenes</i> Rosenbach	Streptococcaceae	<i>S. sesban</i> ⁻	Infections	
<i>Vibrio cholera</i> Pacini	Vibrionaceae	<i>S. grandiflora</i> ⁺	Infections	
Fungi				
<i>Aspergillus niger</i> Tiegh.	Trichocomaceae	<i>S. grandiflora</i> ⁺ ,	Infections	

Microorganism species	Family	Related <i>Sesbania</i> species	Use Categories	Page
		<i>S. sesban</i> ^{+/-}		
<i>Auricularia auricula-judae</i> (Bull.) Quél.	Auriculariaceae	<i>S. grandiflora</i>	Environmental uses	
<i>Candida albicans</i> (C.P.Robin) Berkhout	Saccharomycetaceae	<i>S. grandiflora</i> ^{+/-} , <i>S. macrantha</i> ⁻ , <i>S. sesban</i> ⁺ , <i>S. sesban</i> var. <i>nubica</i> ⁻	Infections	
<i>Fusarium oxysporum</i> Schltdl.	Nectriaceae	<i>S. bispinosa</i> ⁻	Infections	
<i>Saccharomyces cerevisiae</i> Meyen ex E.C.Hansen	Saccharomycetaceae	<i>S. bispinosa</i> ⁻	Infections	
<i>Trichophyton rubrum</i> (Castell.) Sabour.	Arthrodermataceae	<i>S. sesban</i> ⁻	Infections	

+ = positive effect

- = negative effect

+/- = positive and negative effect

APPENDIX 3

Alphabetical listing of all names of animals mentioned in the review of the economic importance of *Sesbania* species. For each name the author is provided.

Common name	Scientific names	Family	Related <i>Sesbania</i> species	Category	Page
Ants	<i>Oecophylla</i> sp.	Formicidae	<i>S. grandiflora</i>	Digestive System Disorders	
Blood fluke	<i>Schistosoma mansoni</i> Sambon	Schistosomatidae	<i>S. sesban</i>	Infections	
Camel	<i>Camelus</i> sp.	Camelidae	<i>S. quadrata</i> , <i>S. sericea</i> , <i>S. sesban</i> var. <i>nubica</i>	Animal food	
Carp	<i>Cyprinus carpio</i> L.	Cyprinidae	<i>S. bispinosa</i>	Poisons	
Cattle	<i>Bos taurus</i> L.	Bovidae	<i>S. bispinosa</i> , <i>S. cannabina</i> , <i>S. grandiflora</i> , <i>S. sericea</i> , <i>S. sesban</i> var. <i>nubica</i>	Animal food, Veterinary medicine	
Chicken	<i>Gallus gallus domesticus</i> L.	Phasianidae	<i>S. vesicaria</i>	Poisons	
Donkey	<i>Equus africanus asinus</i> L.	Equidae	<i>S. sericea</i> , <i>S. sesban</i> var. <i>nubica</i>	Animal food	
Elephant	<i>Loxodonta africana</i> Blumenbach	Elephantidae	<i>S. greenwayi</i> , <i>S. keniensis</i>	Animal food	
Flying fox bat	<i>Pteropus</i> sp.	Pteropodidae	<i>S. grandiflora</i>	Animal food	
Goat	<i>Capra aegagrus hircus</i> L.	Bovidae	<i>S. cannabina</i> , <i>S. emerus</i> , <i>S. quadrata</i> , <i>S. rostrata</i> , <i>S. sericea</i> , <i>S. sesban</i> , <i>S. sesban</i> var. <i>nubica</i>	Animal food, Veterinary medicine	

Common name	Scientific names	Family	Related <i>Sesbania</i> species	Category	Page
Green stink bug	<i>Chinavia hilaris</i> Say	Pentatomidae	<i>S. punicea</i>	Other economic importance	
Guppy	<i>Poecilia reticulata</i> Peter	Poeciliidae	<i>S. vesicaria</i>	Poisons	
Minnow	<i>Phoxinus phoxinus</i> L.	Cyprinidae	<i>S. vesicaria</i>	Poisons	
Root-knot nematode	<i>Meloidogyne</i> sp.	Meloidogynidae	<i>S. grandiflora</i>	Poisons	
Sheep	<i>Ovis aries</i> L.	Bovidae	<i>S. bispinosa</i> , <i>S. cannabina</i> , <i>S. drummondii</i> , <i>S. grandiflora</i> , <i>S. quadrata</i> , <i>S. sericea</i> , <i>S. sesban</i> , <i>S. sesban</i> var. <i>nubica</i>	Animal food, Veterinary medicine, Poisons	
Tick			<i>Sesbania macrantha</i> <i>Sesbania sesban</i>	Veterinary medicine	
Tilapia	<i>Oreochromis niloticus</i> L.	Cichlidae	<i>S. bispinosa</i>	Poisons	

APPENDIX 4

Alphabetical listing of all common names of plants mentioned in the review of the economic importance of *Sesbania* species providing a cross-reference to the scientific name and the origin of the common name.

Common name	Species	Country	Reference
Agasemara	<i>S. grandiflora</i>	India	Nadkarni, 1976
Agashi	<i>S. grandiflora</i>	India	Khory & Katrak, 1903
Agasta	<i>S. grandiflora</i>	India	Khory & Katrak, 1903; Nadkarni, 1976
Agasthi	<i>S. grandiflora</i>	India	Mallick et al., 2014
Agasthio	<i>S. grandiflora</i>	India	Khory & Katrak, 1903
Agasti phool	<i>S. grandiflora</i>	India	Sinha & Lakra, 2005
Agastya	<i>S. grandiflora</i>	India	Nadkarni, 1976; Sahani & Mall, 2013
Agastoya	<i>S. grandiflora</i>	India	Nadkarni, 1976
Agath	<i>S. grandiflora</i>	India	Khory & Katrak, 1903
Agathi	<i>S. grandiflora</i>	India	Shanmugam et al., 2011; Sarvalingam et al., 2015; Vijayakumar et al., 2015
Agathi keera	<i>S. grandiflora</i>	India	Arinathan et al., 2007
Agathiyo	<i>S. grandiflora</i>	India	Nadkarni, 1976
Agati-keera	<i>S. grandiflora</i>	Sri Lanka	Dasanayake & Fosberg, 1991
Agatti	<i>S. grandiflora</i>	India	Nadkarni, 1976
Agasatibak	<i>S. grandiflora</i>	India	Rajasab & Isaq, 2004
Agse mara	<i>S. grandiflora</i>	India	Rajasab & Isaq, 2004
Akatti	<i>S. grandiflora</i>	India	Nadkarni, 1976
Akatti	<i>S. grandiflora</i>	Sri Lanka	Dasanayake & Fosberg, 1991
Aneesay	<i>S. grandiflora</i>	India	Nadkarni, 1976
Argati	<i>S. grandiflora</i>	India	Nadkarni, 1976
Athi	<i>S. grandiflora</i>	India	Nadkarni, 1976
Avira	<i>S. grandiflora</i>	India	Padal & Sandhya, 2013
Avisa	<i>S. grandiflora</i>	India	Sudarsanam et al., 1995; Padal et al., 2014
Avisachettu	<i>S. grandiflora</i>	India	Padal et al., 2013
Avisi	<i>S. grandiflora</i>	India	Khory & Katrak, 1903; Nadkarni, 1976
Bak	<i>S. grandiflora</i>	India	Khory & Katrak, 1903; Nadkarni, 1976
Bakphul	<i>S. grandiflora</i>	India	Nadkarni, 1976; Bandyopadhyay & Mukherjee, 2009; Adhikari et al., 2018
Basna	<i>S. grandiflora</i>	India	Khory & Katrak, 1903; Nadkarni, 1976
Bock phool	<i>S. grandiflora</i>	Bangladesh	Rahmatullah et al., 2012
Bokful	<i>S. grandiflora</i>	Bangladesh	Islam et al., 2014
Buko	<i>S. grandiflora</i>	India	Nadkarni, 1976
Cecego	<i>S. pachycarpa</i>	Niger	Glew et al., 2005

Common name	Species	Country	Reference
Champai	<i>S. sesban</i>	India	Khory & Katrak, 1903; Nadkarni, 1976
Chogache	<i>S. grandiflora</i>	India	Laddimath & Rao, 2016
Daəm ɲkiə dey	<i>S. grandiflora</i>	Cambodia	Martin, 1971
Daəm snao	<i>S. javanica</i>	Cambodia	Martin, 1971
Dhaincha	<i>S. sesban</i>	India	Upadhyay et al., 2011
Diang piang	<i>S. grandiflora</i>	Thailand	Srithi, 2012
Dok kare	<i>S. grandiflora</i>	Thailand	Tovaranonte, 2003; Panyadee et al., 2016
Dok khanoo	<i>S. javanica</i>	Thailand	Tovaranonte, 2003
Geloŋgai	<i>S. grandiflora</i>	China	Pei, 1985
Getih	<i>S. grandiflora</i>	Malaysia	Corner, 1940
Hadaga	<i>S. grandiflora</i>	India	Nadkarni, 1976
Hathia	<i>S. grandiflora</i>	India	Nadkarni, 1976
Jaint	<i>S. sesban</i>	India	Nadkarni, 1976
Jaintar	<i>S. sesban</i>	India	Nadkarni, 1976
Jalugu	<i>S. sesban</i>	India	Nadkarni, 1976
Janjan	<i>S. sesban</i>	India	Nadkarni, 1976
Janter	<i>S. sesban</i>	Pakistan	Shah & Rahim, 2017
Jaya	<i>S. sesban</i>	India	Khory & Katrak, 1903
Jayante	<i>S. sesban</i>	India	Khory & Katrak, 1903
Jayanti	<i>S. sesban</i>	India	Khory & Katrak, 1903; Tarafdar et al., 2015
Jayantika	<i>S. sesban</i>	India	Nadkarni, 1976
Jet	<i>S. sesban</i>	India	Khory & Katrak, 1903
Jetrasin	<i>S. sesban</i>	India	Nadkarni, 1976
Kaattu agathi	<i>S. javanica</i>	India	Ignacimuthu et al., 2008
Kachang turi	<i>S. grandiflora</i>	Malaysia	Corner, 1940
Karijeenange	<i>S. sesban</i>	India	Khory & Katrak, 1903
Karijeenangi-mara	<i>S. sesban</i>	India	Nadkarni, 1976
Karumsembai	<i>S. sesban</i>	India	Nadkarni, 1976
Katirai	<i>S. grandiflora</i>	Philippines	Abe & Ohtani, 2013
Katuday	<i>S. grandiflora</i>	Philippines	Bodner & Gereau, 1988
Katuru murunga	<i>S. grandiflora</i>	India	Nadkarni, 1976
Katuru-murunga	<i>S. grandiflora</i>	Sri Lanka	Dasanayake & Fosberg, 1991
Kae	<i>S. grandiflora</i>	Thailand	Inta, 2008
Kayu ambun	<i>S. bispinosa</i>	Indonesia	Grosvenor et al., 1995
Kedangu	<i>S. sesban</i>	India	Nadkarni, 1976
Khae	<i>S. grandiflora</i>	Thailand	Thongpairojn, 1999; Upho, 2005; Inta, 2008; Srisopa, 2008; Yooyen, 2012; Muangyen, 2013
Khae baan	<i>S. grandiflora</i>	Thailand	Smitinand, 1990; Ponpim, 1996; Tangtragoon, 1998; Niyomyat, 1999; Thongpairojn, 1999; Humphanon et

Common name	Species	Country	Reference
			al., 2002; Chumnasiao, 2004; Tangtragoon et al., 2004; Srisopa, 2008; Oundech, 2009; Junkhonkaen, 2012; Ngamsiri, 2015
Khae dok khao	<i>S. grandiflora</i>	Thailand	Ngamsiri, 2015
Khae dok daeng	<i>S. grandiflora</i>	Thailand	Ngamsiri, 2015
Khae khao	<i>S. grandiflora</i>	Thailand	Tovaranonte, 2001
Korbokae	<i>S. grandiflora</i>	Thailand	Thongdonair, 2003
Lohori	<i>S. sesban</i>	Kenya	Ochwang'i et al., 2014
Lum dok kae	<i>S. grandiflora</i>	Thailand	Srithi, 2012
Mbondo	<i>S. microphylla</i>	Tanzania	Moshi et al., 2012
Mokgabane	<i>S. punicea</i>	South Africa	Semenya et al., 2012
More	<i>S. pachycarpa</i>	Burkina Faso	Nadembega et al., 2011
Mostaza	<i>S. emerus</i>	Ecuador	Madsen et al., 2001
Mostaza de Monte	<i>S. emerus</i>	Ecuador	Madsen et al., 2001
Msenga	<i>S. microphylla</i>	Tanzania	Moshi et al., 2012
Muwoganyanja	<i>S. grandiflora</i>	Uganda	Lamorde et al., 2010
Muzimbandegeya	<i>S. sesban</i>	Uganda	Ssegawa & Kasenene, 2007
Muzimbandeya	<i>S. sesban</i>	Uganda	Tugume et al., 2016
Nadeyi	<i>S. sesban</i>	India	Khory & Katrak, 1903
Nallasominta	<i>S. sesban</i>	India	Nadkarni, 1976
Ntatemba	<i>S. grandiflora</i>	Uganda	Lamorde et al., 2010
Olukhulila mbusi	<i>S. sesban</i>	Kenya	Ochwang'i et al., 2014
Omukhule	<i>S. sesban</i>	Kenya	Ochwang'i et al., 2014
Oyieko	<i>S. sesban</i>	Kenya	Geissler et al., 2002
Phak hong haeng	<i>S. javanica</i>	Thailand	Srisopa, 2008
Rang dok kae	<i>S. grandiflora</i>	Thailand	Tangtragoon, 1998
Rasin	<i>S. sesban</i>	India	Khory & Katrak, 1903
Ravasin	<i>S. grandiflora</i>	India	Khory & Katrak, 1903
Rawsan	<i>S. sesban</i>	India	Sikarwar & Kaushik, 1993
Sano	<i>S. javanica</i>	Thailand	Pongpangan & Poobrasert, 1972; Srisopa, 2008; Ngamsiri, 2015
Sano kin dok	<i>S. javanica</i>	Thailand	Tovaranonte, 2003; Srisopa, 2008; Ngamsiri, 2015
Sano hin	<i>S. javanica</i>	Thailand	Srisopa, 2008
Shevari	<i>S. sesban</i>	India	Khory & Katrak, 1903; Nadkarni, 1976
Sishiban	<i>S. sesban</i>	India	Khory & Katrak, 1903
Sithagathi	<i>S. sesban</i>	India	Nadkarni, 1976
Somanti	<i>S. sesban</i>	India	Khory & Katrak, 1903; Nadkarni, 1976
Sthulapushpa	<i>S. grandiflora</i>	India	Khory & Katrak, 1903
Tchetcheko	<i>S. pachycarpa</i>	Niger	Glew et al., 2005
Tella sumintha	<i>S. grandiflora</i>	India	Padal et al., 2015

Common name	Species	Country	Reference
Theya	<i>S. sesban</i>	India	Chander et al., 2015
Tood rang jaak	<i>S. grandiflora</i>	Thailand	Srithi, 2012
Toori	<i>S. grandiflora</i>	Indonesia	Ochse & van den Brink, 1977; Shurtleff & Aoyagi, 1979
Toroj	<i>S. grandiflora</i>	Indonesia	Ochse & van den Brink, 1977
Turi	<i>S. grandiflora</i>	Indonesia	Shurtleff & Aoyagi, 1979; Zumsteg & Weckerle, 2007; Caruso et al., 2013
Turi	<i>S. grandiflora</i>	Malaysia	Corner, 1940
Umunyegenyege	<i>S. sesban</i>	Burundi	Ngezahayo et al., 2015
Vaija Yanta	<i>S. sesban</i>	India	Khory & Katrak, 1903
Vranari	<i>S. grandiflora</i>	India	Khory & Katrak, 1903
Zuzuma	<i>S. sesban</i>	Tanzania	Maregesi et al., 2007

APPENDIX 5

Alphabetical listing of all chemicals and compounds mentioned in the review of the economic importance of *Sesbania* species. For each chemical and compound the *Sesbania* species that contains it is mentioned, and the use-category is mentioned

Chemicals and compounds	Related <i>Sesbania</i> species	Category
1-O- β -D-glucopyranosyl-2-hydroxy-N-pentadecanamide	<i>S. bispinosa</i>	Inflammation
2-hydroxy-N-decanamide	<i>S. bispinosa</i>	Inflammation
Alkaloids	<i>S. grandiflora</i>	Human food
Alkaloids	<i>S. herbacea</i>	Nutritional Disorders
Alkaloids	<i>S. rostrata</i>	Nutritional Disorders
Alkaloids	<i>S. sesban</i>	Nutritional Disorders
Amino acids	<i>S. grandiflora</i>	Human food
Amino acids	<i>S. pachycarpa</i>	Human food
Anthocyanin	<i>S. grandiflora</i>	Human food
Ascorbate peroxidase	<i>S. drummondii</i>	Environmental uses
Betulinic acid	<i>S. grandiflora</i>	Infections
Calcium	<i>S. bispinosa</i>	Human food
Calcium	<i>S. grandiflora</i>	Human food
Calcium	<i>S. pachycarpa</i>	Human food
Carbohydrate	<i>S. grandiflora</i>	Human food
Carotene	<i>S. grandiflora</i>	Human food
Carotenoid	<i>S. grandiflora</i>	Human food
Catechin	<i>S. virgata</i>	Other economic importance
Chlorophyll	<i>S. grandiflora</i>	Human food
Cobalt	<i>S. pachycarpa</i>	Human food
Copper	<i>S. bispinosa</i>	Human food
Copper	<i>S. pachycarpa</i>	Human food
Fat	<i>S. grandiflora</i>	Human food
Fatty acids	<i>S. pachycarpa</i>	Human food
Flavonoids	<i>S. grandiflora</i>	Human food
Glutathione	<i>S. drummondii</i>	Environmental uses
Glutathione reductase	<i>S. drummondii</i>	Environmental uses
Glycosides	<i>S. grandiflora</i>	Human food
Iron	<i>S. bispinosa</i>	Human food
Iron	<i>S. grandiflora</i>	Human food
Iron	<i>S. pachycarpa</i>	Human food
Isovestitol	<i>S. grandiflora</i>	Infections
L-Dopa	<i>S. bispinosa</i>	Human food
Linoleic acid	<i>S. grandiflora</i>	Human food
Linoleic acid	<i>S. pachycarpa</i>	Human food
Lipid	<i>S. bispinosa</i>	Human food
Lipid	<i>S. herbacea</i>	Nutritional Disorders
Lipid	<i>S. rostrata</i>	Human food

Chemicals and compounds	Related <i>Sesbania</i> species	Category
Lipid	<i>S. rostrata</i>	Nutritional Disorders
Lipid	<i>S. sesban</i>	Human food
Lipid	<i>S. sesban</i>	Nutritional Disorders
Lutein	<i>S. grandiflora</i>	Human food
Lutein	<i>S. grandiflora</i>	Sensory System Disorders
Magnesium	<i>S. bispinosa</i>	Human food
Magnesium	<i>S. pachycarpa</i>	Human food
Manganese	<i>S. bispinosa</i>	Human food
Manganese	<i>S. pachycarpa</i>	Human food
Medicarpin	<i>S. grandiflora</i>	Infections
Neoxanthin	<i>S. grandiflora</i>	Human food
Oleanolic acid 3- β -D-glucuronide	<i>S. sesban</i>	Genitourinary System Disorders
Oxalate	<i>S. grandiflora</i>	Human food
Phenolic acid	<i>S. grandiflora</i>	Human food
Phenols	<i>S. bispinosa</i>	Human food
Phenols	<i>S. grandiflora</i>	Human food
Phenols	<i>S. rostrata</i>	Human food
Phenols	<i>S. sesban</i>	Human food
Phosphorus	<i>S. bispinosa</i>	Human food
Phosphorus	<i>S. pachycarpa</i>	Human food
Phytate	<i>S. bispinosa</i>	Human food
Phytate	<i>S. grandiflora</i>	Human food
Phytate	<i>S. javanica</i>	Human food
Phytate	<i>S. rostrata</i>	Human food
Phytate	<i>S. sesban</i>	Human food
Pinitol	<i>S. bispinosa</i>	Endocrine System Disorders
Polyphenols	<i>S. grandiflora</i>	Human food
Potassium	<i>S. bispinosa</i>	Human food
Potassium	<i>S. pachycarpa</i>	Human food
Protein	<i>S. bispinosa</i>	Human food
Protein	<i>S. grandiflora</i>	Human food
Protein	<i>S. javanica</i>	Human food
Protein	<i>S. pachycarpa</i>	Human food
Protein	<i>S. rostrata</i>	Human food
Protein	<i>S. sesban</i>	Human food
Saponin	<i>S. bispinosa</i>	Human food
Saponin	<i>S. grandiflora</i>	Human food
Saponin	<i>S. rostrata</i>	Human food
Saponin	<i>S. sesban</i>	Human food
Saponin	<i>S. sesban</i>	Inflammation
Saponin	<i>S. vesicaria</i>	Poison
Saponin	<i>S. vesicaria</i>	Neoplasms
Sativan	<i>S. grandiflora</i>	Infections

Chemicals and compounds	Related <i>Sesbania</i> species	Category
Sesbanimide	<i>S. bispinosa</i>	Other economic importance
Sesbanimide	<i>S. drummondii</i>	Neoplasms
Sesbanimide	<i>S. punicea</i>	Neoplasms
Sesbanimide	<i>S. punicea</i>	Other economic importance
Sesbanimide	<i>S. vesicaria</i>	Neoplasms
Sodium	<i>S. bispinosa</i>	Human food
Sodium	<i>S. pachycarpa</i>	Human food
Starch	<i>S. bispinosa</i>	Human food
Starch	<i>S. rostrata</i>	Human food
Stigmasterol	<i>S. bispinosa</i>	Human food
Stigmasterol	<i>S. bispinosa</i>	Endocrine System Disorders, Muscular-Skeletal System Disorders
Stigmasterol	<i>S. grandiflora</i>	Endocrine System Disorders, Muscular-Skeletal System Disorders
Superoxide dismutase	<i>S. drummondii</i>	Environmental uses
Tannin	<i>S. bispinosa</i>	Human food
Tannin	<i>S. grandiflora</i>	Human food
Tannin	<i>S. grandiflora</i>	Digestive System Disorders, Neoplasms
Tannin	<i>S. javanica</i>	Human food
Tannin	<i>S. javanica</i>	Digestive System Disorders
Tannin	<i>S. rostrata</i>	Human food
Tannin	<i>S. sesban</i>	Human food
Tannin	<i>S. sesban</i>	Neoplasms
Thiols	<i>S. drummondii</i>	Environmental uses
Triterpene acid 3-O- α -L-rhamnopyranoside	<i>S. bispinosa</i>	Inflammation
Violaxanthin	<i>S. grandiflora</i>	Human food
Vitamin B1	<i>S. grandiflora</i>	Human food
Vitamin B2	<i>S. grandiflora</i>	Human food
Vitamin C	<i>S. grandiflora</i>	Human food
Vitamin C	<i>S. javanica</i>	Human food
Zeaxanthin	<i>S. grandiflora</i>	Human food
Zeaxanthin	<i>S. grandiflora</i>	Sensory System Disorders
Zinc	<i>S. bispinosa</i>	Human food
Zinc	<i>S. pachycarpa</i>	Human food
α -linoleic acid	<i>S. grandiflora</i>	Human food
α -linoleic acid	<i>S. pachycarpa</i>	Human food
β -carotene	<i>S. grandiflora</i>	Human food
β -sitosterol	<i>S. bispinosa</i>	Human food

APPENDIX 6

Alphabetical listing of all countries mentioned in the review of the economic importance of *Sesbania* species. For each country the name of the used species and the use category are mentioned.

Country	Species	Category ^a
	Africa	
Burkina Faso	<i>S. pachycarpa</i>	CSD, GSD, Infe, RSD, SSD
Burundi	<i>S. sesban</i>	Infe, Infl
Ethiopia	<i>S. somalensis</i>	Animal food
Ethiopia	<i>S. sesban</i>	RSD
Ethiopia	<i>S. sesban</i>	Environmental uses
Kenya	<i>S. macrantha</i>	Vet
Kenya	<i>S. sericea</i>	Animal food
Kenya	<i>S. sesban</i>	Neo, NSD, UMD, Vet
Kenya	<i>S. sesban</i> var. <i>nubica</i>	Animal food
Madagascar	<i>S. sesban</i> subsp. <i>punctata</i>	Infe
Senegal	<i>S. pachycarpa</i>	Human food
Senegal	<i>S. sericea</i>	Human food
Somalia	<i>S. quadrata</i>	Animal food
Somalia	<i>S. somalensis</i>	Animal food
South Africa	<i>S. punicea</i>	GSD
Sudan	<i>S. leptocarpa</i>	Other economic importance
Sudan	<i>S. sesban</i>	Infe
Tanzania	<i>S. keniensis</i>	Animal food
Tanzania	<i>S. keniensis</i>	Environmental uses
Tanzania	<i>S. hirtistyla</i>	Abn
Tanzania	<i>S. microphylla</i>	Infe
Tanzania	<i>S. sesban</i>	Infe
Uganda	<i>S. grandiflora</i>	Infe
Uganda	<i>S. sesban</i>	CSD, DSD, ESD, Infe, PD, UMD
Zambia	<i>S. greenwayi</i>	Animal food
	Asia	
Bangladesh	<i>S. grandiflora</i>	Infe, NSD, Pa, RSD, SCTD
Cambodia	<i>S. grandiflora</i>	Human food
Cambodia	<i>S. grandiflora</i>	DSD, Pa
Cambodia	<i>S. javanica</i>	Human food
Cambodia	<i>S. javanica</i>	Infe
Cambodia	<i>S. javanica</i>	Environmental uses
China	<i>S. grandiflora</i>	Human food
China	<i>S. grandiflora</i>	Environmental uses
India	<i>S. bispinosa</i>	Vet
India	<i>S. bispinosa</i>	Environmental uses
India	<i>S. cannabina</i>	Human food

Country	Species	Category ^a
India	<i>S. cannabina</i>	Animal food
India	<i>S. cannabina</i>	Environmental uses
India	<i>S. concolor</i>	Other economic importance
India	<i>S. grandiflora</i>	Human food
India	<i>S. grandiflora</i>	Animal food
India	<i>S. grandiflora</i>	DSD, GSD, Infe, Infl, Inj, MD, Neo, NSD, Pa, Po, RSD, SSD, SCTD, UMD, Vet
India	<i>S. grandiflora</i>	Environmental uses
India	<i>S. grandiflora</i>	Fuel
India	<i>S. grandiflora</i>	Social uses
India	<i>S. javanica</i>	Pa
India	<i>S. sesban</i>	Human food
India	<i>S. sesban</i>	ESD, GSD, Infe, Inj, MSSD, Pa, RSD, SCTD, Vet
India	<i>S. sesban</i>	Environmental uses
India	<i>S. sesban</i>	Fuel
India	<i>S. sesban</i> subsp. <i>punctata</i>	Human food
India	<i>S. sesban</i> var. <i>bicolor</i>	Environmental uses
India	<i>S. speciosa</i>	Environmental uses
Indonesia	<i>S. bispinosa</i>	Infe
Indonesia	<i>S. grandiflora</i>	Human food
Indonesia	<i>S. grandiflora</i>	Animal food
Indonesia	<i>S. grandiflora</i>	PD, Vet
Indonesia	<i>S. grandiflora</i>	Environmental uses
Indonesia	<i>S. grandiflora</i>	Fuel
Indonesia	<i>S. grandiflora</i>	Other economic importance
Indonesia	<i>S. sesban</i>	Environmental uses
Iraq	<i>S. cannabina</i>	Environmental uses
Malaysia	<i>S. bispinosa</i>	Human food
Malaysia	<i>S. grandiflora</i>	Human food
Malaysia	<i>S. grandiflora</i>	PD
Malaysia	<i>S. grandiflora</i>	Environmental uses
Myanmar	<i>S. grandiflora</i>	Human food
Myanmar	<i>S. sesban</i>	Environmental uses
Pakistan	<i>S. concolor</i>	Other economic importance
Pakistan	<i>S. sesban</i>	Infe
Philippines	<i>S. grandiflora</i>	Human food
Philippines	<i>S. grandiflora</i>	DSD
Philippines	<i>S. grandiflora</i>	Environmental uses
Sri Lanka	<i>S. grandiflora</i>	Animal food
Sri Lanka	<i>S. grandiflora</i>	Po
Thailand	<i>S. grandiflora</i>	Human food
Thailand	<i>S. grandiflora</i>	Animal food
Thailand	<i>S. grandiflora</i>	Poisons

Country	Species	Category ^a
Thailand	<i>S. grandiflora</i>	Abn, CSD, DSD, Infe, Inj, ND, Pa, RSD, UMD
Thailand	<i>S. grandiflora</i>	Environmental uses
Thailand	<i>S. javanica</i>	Human food
Thailand	<i>S. javanica</i>	Inj
Thailand	<i>S. speciosa</i>	Human food
Vietnam	<i>S. cannabina</i>	Environmental uses
	Australia	
Australia	<i>S. cannabina</i>	Other economic importance
Australia	<i>S. grandiflora</i>	Environmental uses
Fiji	<i>S. cannabina</i>	Environmental uses
Fiji	<i>S. grandiflora</i>	Environmental uses
Papua New Guinea	<i>S. speciosa</i>	Other economic importance
	North America	
Mexico	<i>S. longifolia</i>	Human food
USA	<i>S. drummondii</i>	Other economic importance
USA	<i>S. herbacea</i>	Environmental uses
USA	<i>S. herbacea</i>	Other economic importance
USA	<i>S. punicea</i>	Other economic importance
USA	<i>S. sesban</i>	Fuel
USA	<i>S. tomentosa</i>	Environmental uses
	South America	
Bolivia	<i>S. virgata</i>	Pa
Ecuador	<i>S. emerus</i>	Animal food
Ecuador	<i>S. emerus</i>	Animal food

^aThe abbreviations for subcategories of medicines apply as follow: Abn = Abnormalities, CSD = Circulatory System Disorders, DSD = Digestive System Disorders, ESD = Endocrine System Disorders, GSD = Genitourinary System Disorders, Infe = Infections/ Infestations, Infl = Inflammation, Inj = Injuries, MD = Mental Disorders, MSSD = Muscular-Skeletal System Disorders, Neo = Neoplasms, NSD = Nervous System Disorders, ND = Nutritional Disorders, Pa = Pain, Po = Poisonings, PD = Pregnancy/Birth/Puerperium Disorders, RSD = Respiratory System Disorders, SSD = Sensory System Disorders, SCTD = Skin/Subcutaneous Cellular Tissue Disorders, UMD = Unspecified Medical Disorders, Vet = Veterinary medicine