Ecology, Morphology, Distribution, and Use of *Sesbania tchadica* (*Sesbania Sesban*) from the Republic of Chad: A Review.

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Key message: A review of literature of potential uses and a survey study about the tree *Sesbania tchadica* (*Sesbania Sesban*) leguminous native from the Republic of Chad are described in this paper.

Abstract: This study on the leguminous plant *Sesbania tchadica* has made it possible to highlight its description, specification and identification in N'Djamena region. *S. tchadica* (*Sesbania Sesban Merr. (L)*) is an annual tree that measures more than 4 meters in height. This species is abundant especially in Ndjamena. In most of the district of Ndjamena, *S. tchadica* was the most common type. *S. tchadica* shows a rapid early growth and grows well in various soils especially sandy siltstone and silty shale. The local inhabitants use the species in many ways: as a medicine, a livestock feed, for improving soil fertility, for fuelwood and to repel desert encroachment. In this study, various academic publishing websites like Science Direct, Springer Nature, some online international plant databases, and other national data herbaria from the republic of Chad were used to identify, describe and summarize the research literature on *Sesbania Sesban*. This paper also describes the morphological characteristics observed in *Sesbania Sesban* from the republic of Chad and its taxonomy to assist in future program evaluations.

Keywords: *Sesbania tchadica* (*Sesbania sesban*); leguminosae; morphology; distribution; flora of Chad.

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Introduction

The taxonomic diversity of legumes is enormous. In addition, they provide important benefits to humans including food, medicines, and environmental services. For example, leguminous food grains include beans (*Phaseolus vulgaris* L.), peas (*Pisum sativum* L.), soya beans (*Glycine max* L.), and forage legumes such as clover (*Trifolium repens* L.), sainfoin (*Onobrychis* Mill.) and *Sesbania sesban*. Other legumes are ornamental, (*Cercis siliquastrum, Acacia mollissima*) melliferous (*Robinia pseudoacacia, Melilotus albus*), or medicinal (*Ceratonia siliqua, Trigonella foenum-graecum, Sesbania sesban*). These plants (leguminosae) also fix atmospheric nitrogen via their symbiotic association with soil bacteria, belonging to the genera *Rhizobium, Azorhizobium, Bradyrhizobium, Synorhizobium* (Lahdachi et al., 2015). They can be used for soil improvement. They are among the world's most important crops (Toomsan et al., 2012) (Rochester et al., 2001). They provide nutritious bodybuilding food for man and animals the world over (Li et al., 2017). In addition to being rich in protein, leguminous crops are also high in bone-building fibers,
complex carbohydrates, minerals, and vitamins essential to good health (Polak et al., 2015) (Maria et al., 2021). They can obtain most of the nitrogen they need from the vast supply of gaseous nitrogen in the air (Cocking, 2000). Air is about 78 percent nitrogen; there are around 6 400 kilograms of nitrogen above every hectare of land and water (NifTAL, 1985). These plants gather and use this nitrogen by working symbiotically with special bacteria (rhizobia) in nodules on their roots (Ndoye & Dreyfus, 1988) (Sharma et al., 2005). Rhizobia infect the root hairs of the leguminous host; nodules develop and become small nitrogen factories on the legume roots. The host plant provides a home for the bacteria and energy to fix or gather air nitrogen. In return, the plant receives fixed nitrogen from the nodule and produces food and forage protein (NifTAL, 1985) (Mmoudiongh. & Rinaudoe, 1985) (Abdel Magid et al., 1988) (Sembal et al., 2021). They also leave fixed nitrogen in the soil for succeeding crops (Dakora F. D. and Keya S. O., 1997) (Toomsen et al., 2012). Since nitrogen is commonly the most limiting element in food production, and one of the most expensive in fertilizer, this special ability of leguminous crops to work symbiotically with rhizobia to produce protein is becoming increasingly important in world agriculture (Silesi et al., 2014). Some forage legumes such as Sesbania sp. are used in agroforestry in tropical regions for other purposes such as stakes, fuelwood and reducing soil erosion. Land management practices featuring legumes include cereal-legume intercropping, relay cropping, biomass transfer and fodder banks (Ndungu and Boland, 1994) (Kwesiga et al., 1999) (Orwa et al., 2009) (Silesi et al., 2014). In general, leguminous species from arid habitats play a great role in reforestation development programs and in the fight against desertification (Curasson, 1956) (Bashan et al., 2012). They are suitable alone or mixed with other species for use in arid zone agriculture (Bradbury, 1990). Moreover, the integration of legume trees increases yield stability in cropping systems and prevents land degradation (Silesi et al., 2008) (Silesi et al., 2012). These characteristics give these « fertilizer trees » a very important economic and environmental value (Kiptot et al., 2014).

The genus Sesbania sp. includes many species indigenous to Africa such as S. goetzei, S. keniensis S. rostrata and S. sesban, which possess several desirable characteristics that make them suitable for use as multipurpose trees in farming systems, particularly S. sesban (Heering, 1995). Endemic Sesbania sp found in Chad are Sesbania tchadica (Sesbania sesban), Sesbania dalzielii, S. rostrata and others (Jean and Cyrille, 2019).

One of the most serious constraints to the sustainability of agriculture in sub-Saharan Africa is soil nutrient depletion (Bindraban et al., 2012). Many factors cause the decline of soil fertility and carbon stocks of African drylands including deforestation, overgrazing, unsustainable agriculture, and climate change (DeRouw, 1998) (Bakhoum et al., 2018). One of the solutions is the use of mineral fertilizer; however, they are expensive and unsustainable. To address these challenges, scientists have experimented on low cost agroforestry options for soil fertility replenishment (Bindraban et al., 2012). Planting nitrogen fixing trees such as S. sesban (S. tchadica) is an effective solution for increasing soil productivity (Bakhoum et al., 2018). The International Center for Agroforestry Research (ICRAF) is interested in the role of Sesbania sesban in improved fallows especially in savannah woodland region (Anon, 1992) (Ndungu and Boland, 1994) (Kwesiga et al., 1999). Improved fallows involve planting mainly legume tree/shrub species in rotation with cultivated crops. In Zambia, ICRAF researchers found that growing Sesbania in depleted agricultural fields or on fallow lands for 2 or 3 years and then introducing a hybrid maize crop after the fallow period produced exciting and encouraging results. Without N fertilizers, maize yields were 2.3 t ha-1 after 1 year of Sesbania fallow; 5.6 t ha-1, after 2 years; and 6.0 t ha-1, after 3 years. Continuous maize crops gave only 1.5 t ha-1 (Anonymous, 1985). Shrubs (mostly legumes) and annual crops may be grown together and the shrubs retained as fallows for 2–3 years to improve the soil (Dagar and Tewari, 2017). Afterwards, crops are grown (Kwesiga et al., 1999). Intercropping sweetpotato with other leguminous plants such as Sesbania sesban improves yield of the crop (Muimba-Kankolongo, 2018). Sesbania tchadica (Sesbania Sesban) has many other uses in domestic, environmental, fiber, food, beverages, forage, medicine and wood products and services (Richard and ILDIS, 2018). The objective of this paper is to give a general morphological identification and description of Sesbania tchadica A. Chev.
from the republic of Chad. This paper provides also an overview and updated information concerning this very useful but less-exploited plant with the purpose to help develop and conserve it.

1- Material and methods:

Study area: N'Djamena is the administrative capital and the largest city of Chad Republic. It is located in the center-west of the country (Figure 1), at the confluence of the Chari and Logone rivers. Its population is estimated in 2020 at 1,422,547 habitants with a total growth rate of the country about 3.69% (UN, 2021). N'Djamena has a tropical, arid climate, including a long dry season (7 to 8 months, November to May) and a short wet season (3 to 5 months, May to October). Rainfall varies between 400 to 700 mm/year with many heavy showers. In recent years, rain falls mainly over a three-month period (July-September). Temperatures observed are between 20°C and 45°C in the dry season and 18°C and 30°C in the rainy season (FAO, 2012).

Figure 1: Study area: Map of the Republic Chad and N’Djamena area.

Sampling of the species: The data for this study on Sesbania tchadica (Sesbania sesban) was collected as part of a larger study on medicinal plants of Chad. The morphological determination of Sesbania tchadica is based on the empirical keys determination of plant species (leaves and pods forms, leaves and pods forms, flower form, leaflets form, inflorescence disposition, standard form and position, and plant and branch size). In order to present distinct morphological groups between Sesbania tchadica and other Sesbania sp., leaves and branches were harvested and organized according to their morphology (Figures 6 and 7). The identification and confirmation of the species is based on a comparison of the samples with those of the herbarium of Toumaï Institute, the herbarium of the Livestock Research Institute for Development Institut de Recherche en Élevage pour le Développement (IRED) (N’Djamena) and assessments by foresters from the National Federation of Associations of Healers and Practitioners of Medicine Fédération Nationale des Associations des Praticiens de la Médicine au Tchad (FENAPMT) (which is under the supervision of the Ministry of Public Health of Chad). The species (Accession number: N° 48 TI (Toumaï Institute)) is
registered in the herbariums of the Toumaï Institute, the IRED and then in the Applied Biology and Pathology Laboratory Herbarium (Morocco). The authors also conducted a review of the literature on *Sesbania tchadica* (*Sesbania sesban*), its applications in biochemistry and its interactions with other organisms and its environment.

### 2- Results

*Sesbania tchadica* A. Chev. (Augustin Chevalier): ‘’Sesbania’’ is a Persian term and in the Arabic language is ‘’Saysaban’’. The original taxon was created by Antonio Jose Cavanilles (1745-1804) and modified by George Bentham in 1859 in his book Flora brasiliensis (Gillett, 1963). However, the names “Sesbania” (Auguste, 1913), “Seseban” and “Sesban” already existed (Gillett, 1963). Related names or synonyms are *Sesbania Sesban* var. nubica, *Sesbania sesban* Merr. (L) (Ndungu and Boland, 1994) (Baker, 1926) or *Sesbania aegyptiaca* auct. non Pers. (Jean and Cyrille, 2019). The local name in Chad is Seysaban, Surridj alkoubar or Surridj addougag (Patrice, 1997). The following table shows the taxonomic classification of *Sesbania tchadica* (table 1).

**Table 1: Sesbania tchadica** taxonomic classification (Gillett, 1963) ; (Taugourdeau Simon et al., 2019) ; (IPNI, 2020).

| Kingdom         | Planteae |
|-----------------|----------|
| Division        | Magnoliophyta or Angiosperms dicotyledonous (Flowering plants) |
| Tribe           | Robinieae |
| Classe          | Magnoliopsida |
| Order           | Fabales |
| Family          | Fabaceae |
| Subfamily       | Papilionoideae |
| Gender          | Sesbania |
| Species         | *Sesbania Sesban* (L.) Merr. (*Sesbania tchadica* A. Chev.) |

**Range:** The genus *Sesbania* (Fabaceae or Papilionoideae) is composed of annual shrubs and perennial woody plants that are widespread in the tropics and subtropics (Jammadas et al., 2005). *Sesbania tchadica* is an indigenous species of Chad with a height between four and five meters. The only other African countries where *Sesbania* sp is found in native habitat only are Egypt, Kenya and Uganda (Orwa et al., 2009) (Figure 2).
**Figure 2:** *Sesbania sesban* Merr. (L) in Chad and others African countries (Orwa et al., 2009).

**Habitat and Ecology:** *Sesbania sesban* grows well in the subtropics and in cooler, higher elevation regions of the tropics. It withstands waterlogging and is ideally suited to seasonally-flooded environments (Orwa et al., 2009). It occurs naturally in wet habitats such as lake shores, on muddy river banks and seasonally flooded valley bottoms (Ndungu and Boland, 1994); (Jammadass et al., 2005), but also grows in open savannah (George & Gottwald, 2009) and dry, semi-arid zones (Mohammed Abbas et al., 2001). It grows in a wide variety of soils from loose sandy soils to heavy clays (Ndungu and Boland, 1994); (Jamnadass et al., 2005). but also grows in open savannah (George & Gottwald, 2009) and dry, semi-arid zones (Mohammed Abbas et al., 2001). It grows in a wide variety of soils from loose sandy soils to heavy clays (Heuzé et al., 2016). In Chad, especially in N’Djamena, *Sesbania tchadica* (*Sesbania Sesban*) often occurred in different types of soil: silt siltstone, limestone, silty shale, sandy soils, and clays (Figure 3B).

**Biophysical limits:** The mean annual growing temperature of *Sesbania sesban* is between 18 °C and 23 °C (maximum 45 °C) and the mean annual rainfall is from 500 to 2000 mm. The mean altitude is between 100 and 2300m. *Sesbania tchadica* grows at altitude around 300m (Orwa et al., 2009).

**Pests and diseases:** *Sesbania sp* is attacked by nematodes, insects, fungi and viruses (Orwa et al., 2009). The leaf-eating beetle *Mesoplatys ochroptera* can completely defoliate *Sesbania* leading to mortality. Caterpillars, Hymenoptera, and stem borers attack *S. sesban*. Some potentially destructive root-knot nematodes have been recorded in India on *S. sesban* (Orwa et al., 2009). *Sesbania* is infected by mild and severe mosaic disease virus, which is transmitted from sap and root, showing vein clearing and reduction of leaflets. The prevalence of infection of mosaic disease virus ranges from 5-20%. *Sesbania* plants grown “in vitro” with mild mosaic virus inoculation had fewer pods and were very small in size. The virus inoculated “in vitro” has a great tolerance of dilution (between 1,000-10,000), a resistance to heat (40-60°C) and has long longevity in vitro varying between 10-14 days and (10-25°C) (Mall and Kisan, 2003).

**Distribution of Sesbania sesban in Africa and in the area of study:** *Sesbania sp.* consists of about 50 species of fast-growing trees, perennial shrubs and herbaceous annuals. Some thirty-three are found in Africa, distributed between central and eastern...
Africa. *Sesbania* species develop wild in most geographical zones of Africa and in many different soil types (Mohammed Abbas et al., 2001). *Sesbania sesban* is the most widely distributed and most important species, with a large number of accessions collected (Heering, 1995). In Chad, the genus *Sesbania* sp is represented by many species: *Sesbania tchadica* A. Chev. (*Sesbania sesban* (L.)) (Figure 4), *Sesbania microphylla* Harms ex Phill & Hutch, *Sesbania leptocarpa* D.C., *Sesbania pachycarpa* D.C., *Sesbania pubescens* D.C., *Sesbania rostrata* Brem. & Oberm., *Sesbania sesban* (L.) var. *nubica*, *Sesbania sesban* subsp. *punctata* D.C. & Gillett, *Sesbania dalzielii* E. Phillips & Hutch. (Gaston and Fotuis, 1971) (Jean and Cyrille, 2019). Chad is a center of diversity for some of these species. However, *Sesbania* species have not been fully exploited as multi-purpose plants in many central African countries (Gaston and Fotuis, 1971). Our study shows that the species *S. tchadica* is abundant in the area that the study was conducted. In the most districts of N’Djamena, we found *S. tchadica* to be the most common type (Figure 3A). It shows a rapid early growth and grows well in different soil types in Chad (Figure 3B). As reported by Jean and Cyrille (2019) and IPNI (2020), *Sesbania tchadica* (*Sesbania sesban*) is localized also in Chad in different zones like: riverbanks, stream beds, riparian; water sources of Borkou and Ennedi (Figure 4).

**Figure 3:** A: Location of *Sesbania tchadica* (*Sesbania sesban*) in the study area. B: Soil types in the study area.
**Figures 4:** In orange color: Zones of Chad where *Sesbania tchadica* A. Chev (*Sesbania sesban* Merr.) is found (IPNI, 2020) (GBIF, 2020). In black point: Zones of Chad where *Sesbania tchadica* (*Sesbania sesban*) is found (Jean and Cyrille, 2019).

**Morphological description:** *Sesbania tchadica* (*Sesbania Sesban*) has several basal stems that spread with spiked branches (Figure 5A). Its branches are organized with opposite pairs of leaves as a straight line, with points that look like hair. There are at least 20 pairs of leaves that cross one by one each 180° from the previous, forming a cone that gradually closes (Jean and Cyrille, 2019). These leaves are odd-pinnate with one pair of leaflets at the base with large irregularly-lobed terminal leaflets (Figure 5A). Pods are light green in color just after formation and yellow in color when maturing (Figure 5B). Five to seven pods are grouped together, in grapes form (Figure 5A). Pods and leaves drawing are presented in figure 6C (Jean and Cyrille, 2019). The flowers are yellow and are arranged in clusters forming from two to 20 flowers and almost 20 cm long (figure 6A). The Filament-sheath is 9-13 mm, the inflorescence is never branched and is yellow speckled with purple or, in rare cases, is pure yellow. The plant glabrescent or glabrous (Figure 5 and figure 6A) (Gillett, 1963) (Ndungu and Boland, 1994) (Jean and Cyrille, 2019). Soaking the seeds in water for a few days is sometimes required to make them germinate (Gillett, 1963). Mani et al., (2011) describe that *Sesbania tchadica* (*Sesbania Sesban*) is a short-lived shrub or small tree up to 8 m tall. Its leaves are pinnately compound, 2-18 cm long with 6-27 pairs of linear oblong leaflets (26 × 5 mm). The raceme has 2-20 flowers which are yellow with purple or brown streaks on the corolla. Pods are sub cylindrical, straight or slightly curved up to 30 cm long and 5 mm wide containing 10-50 seeds. Five varieties of *S. sesban* are recognized botanically but their differences do not correlate strongly with their agricultural value.
For this purpose, we employ survey data collected from Ndjamena to describe the species *Sesbania tchadica* (*Sesbania Sesban*) (Figure 5 and Figure 6).

**Figures 5:**

A: *Sesbania tchadica* (*Sesbania Sesban*): Tree and branches. (Latitude 12° 02’ 0” North Longitude 15° 12’ East). B: Dry pods. C: Drawing pods and leaves.
We note that the botanical missions carried out on *Sesbania tchadica* (*Sesbania Sesban*) date from 1968 by the botanist Léonard, and by the botanists Jean and Cyrille (2019) (Jean and Cyrille, 2019). Léonard collected this species in the region of Lake Chad (Léonard, 1968) (Figures 6).
**Figures 6:** (A) *S. tchadica* (*S. sesban*): leaves, flowers, stems, and fresh pods. (B) The figure shows the botanical mission carried out on the *Sesbania sesban* species in Lake Chad area (Léonard, 1968).

**Medicinal and other benefits, uses and applications of *Sesbania tchadica***: *Sesbania tchadica* (*Sesbania sesban*) is used as a medicine and as a feed for livestock. Healers in Chad use its leaves and bark alone to treat breast cancer, oedemas and wounds (Ousman et al., 2017) (unpublished). In addition, livestock-keepers cut, carry and feed the leaves to ruminants. The pods are also cut and fed to dairy sheep, goats and oxen. These leaves and pods are considered as a high-protein fodder to increase the milk productivity of these animals (Ousman et al., 2017) (unpublished). Several authors have reported on the medicinal value and ethnomedical uses of *S. tchadica* (Moyo et al., 2015). Others reported on the species ecological services such as nodulation, its use in intercropping and in improving fallows (in agriculture), its use as fuelwood (Adelanwa. & Tijani, 2016), for biomass production...
(Zulfiqar et al., 2015), and for its ethno-veterinary performance (Frank et al., 2009) (Mohammed et al., 2010). Sontosh et al., (2017) found that the biomass yield of S. sesban accessions produced at the earlier growing period is used as green manure crop in shorter fallow period (up to 20 days after sowing DAS) in rotation culture of Rice-Rice-Mustard or other similar cropping patterns. Sesonisia sesban produced higher biomass yield at the early growth stages (up to 20 DAS) and its decomposability, organic matter accumulation, and N2-fixing ability may be processed to release as recommended cultivar. S. sesban can be grown in a very short of this rotation culture to maximize organic matter addition to the soil (Sontosh et al., 2017). Details of different uses and applications of Sesbania tchadica (Sesbania Sesban) are shown in Table 2.

**Table 2: Results of a review of literature on the uses of Sesbania tchadica (Sesbania sesban)**

| Use                                          | Types of use and diseases treated                                                                 | Part used and optimal solvents                                                                 | References                                          |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|----------------------------------------------------|
| **Medicinal uses**                            |                                                                                                  |                                                                                                |                                                    |
| Antioxidant activity (saponins and flavonoids, anthocyanins) | Leaves, seeds (ethanolic extracts, methanol)                                                    | (Mani et al., 2011) (Kathiresh et al., 2012)                                                |                                                    |
| Anti-microbial activity (anthocyanins)        | Flower petals (methanol and acidified methanol). Bark (ethanol, diethyl ether, chloroform)       | (Kathiresh et al., 2012)                                                                      | (Arif et al., 2013)                                |
| Anti-inflammatory activity (crude saponins)   | Leaves (methanol)                                                                               | (Tatiya et al., 2013) (Shaikh et al., 2012)                                                 |                                                    |
| Anthelmintic activity (saponin glycosides)    | Leaves, seed (aqueous extracts)                                                                 | (Ibrahim, 1992)                                                                               |                                                    |
| Antidiabetic activity (Triterpenoids, tannins, saponins, glycosides, steroids) | Leaves (aqueous extracts)                                                                       | (Pandhare et al., 2011)                                                                      |                                                    |
| Antinociceptive activity (Sterols, triterpenes flavonoids) | Wood (petroleum ether, Chloroform ethyl acetate)                                                | (Nirmal et al., 2012)                                                                         |                                                    |
| Traditional medicine (in Chad)                | Preparations method                                                                             | (Ousman et al., 2017)                                                                         | (unpublished)                                      |
| (Breast cancer, oedema, swollen glands)       | Breast cancer: -- Maceration of leaves for 48 hours -- Infusion of root, bark Oedema and swollen glands: | | |
| Type of use in agriculture and other applications | Part used | References |
|-------------------------------------------------|-----------|------------|
| Fixes atmospheric nitrogen in the soil           | Tree, roots | Mmoudiongh & Rinaudoe, 1985 (Ndoye & Dreyfus, 1988) |
| Green manure for lowland rice                   |            |            |
| Reduction of nematodes and trapping of *Hirschmannieffia oryzae* et *H. spinicaudata* | Whole tree | Dreyfus & Dommergue, 1981 |
| *Sesbania Sesban* produces nodules that can fix 12 tons of biomass (fresh weight)/hectare for a growth period of 45 |            | Ndoye & Dreyfus, 1988 |
Agricultural uses

| Days in in waterlogged or drained soils. *Sesbania rostrata* compared to *Sesbania Sesban* fixes approximately 110 kg of nitrogen per hectare in 60 days, which places it among the most powerful fixatives *Sesbania* species with a higher dry matter. | Tree, roots | (Patra et al., 2006) |
| *Sesbania sesban* is used as a green manure which increases the nitrogen on the soil (in crops of rice and wheat) | Whole tree | (Sobere, 1991) |
| *Rhizobuim* strains induce root nodules and fix nitrogen from the air on the soil in symbiosis with *Sesbania sp*. Inducing of root nodules *Rhizobuim* strains and nitrogen fixing on the soil in symbiosis with *Sesbania sesban* | Germinated seedlings | (Bala et al., 2002) |
| Improved fallow systems to enhance agricultural productivity by increasing the yields of maize and sorghum by 1.2 - 1.8 mg /hectare and 0.1 - 0.7 mg / hectare, respectively. Apply about 7.3 Mg ha−1 dry matter and 165 kg N ha−1 to irrigated wheat and rice. | Whole tree | (Sharma et al., 2005) |
| Cultivated in rotation with cotton to enhance nitrogen fertility and improve soil condition | Whole tree | (Curasson, 1956) (Rochester et al., 2001) |
| The production of nutrients nitrogen, phosphorus, calcium, magnesium potassium by foliar biomass | Whole tree, Bark, Stems | (Balaisubramanian & Sekayange, 1992) (Mohammed Abbas et al., 2001) |
| Biomass yield of *S. sesban* accessions produced is used as green manure crop in shorter fallow. *S. sesban* maximizes organic matter addition to the soil. | Seeds accessions, Whole tree | (Sontosh et al., 2017) |
| Intercropping sweetpotato with *Sesbania sesban* improves yield of the crop | Whole tree | (Muimba-Kankolongo, 2018) |
| Intercropping with rice and annual grasses in semi-arid conditions for managing weeds and optimizing the yield of dry-seeded rice. *Sesbania*, being an aquatic plant, can also be grown together with rice to suppress weeds | Whole tree, Bark | (Mohammed Abbas et al., 2001) (Singh et al., 2007) |
| Improved fallows and as herbaceous cover crops | Whole tree | (Dagar and Tewari, 2017) (Nair, 1993) |
| If used as a supplement, it may improve the cow’s health and shorten the calving interval. | Leave meal | (Roothaert & Paterson, 1997) (Frank et al., 2009) |
| Improving the traditional sheep husbandry: Increased milk and meat production | Leave and young twigs, Whole tree | (Mekoya et al., 2009) (Franzel et al., 2014) |
| Improve smallholder’s livestock productivity, source of | Whole tree | (Franzel et al., 2014) |
Other applications

| Applications                                                                 | Whole tree | References                                      |
|------------------------------------------------------------------------------|-----------|------------------------------------------------|
| revenue, and livelihoods. Fodder, feed livestock tree for dairy goats, sheep, and cows (small ruminants). |           | (Ousman et al., 2017) (unpublished)             |
| Vegetation covers in desert areas. Fodder for livestock (goats, sheep). Increasing the fertility and productivity of sandy soil in the desert area. |           | (Curasson, 1956) (Mohammed Abbas et al., 2001)  |
| Restore eroded soil by fixing N2                                              |           | (Degefu et al., 2011) (Nigussie & Getachew, 2013) |
| Sesbania sesban is used as hedge                                              |           | (Curasson, 1956)                                |
| Sesbania sesban is developed for its wind shade. Sesbania sesban is used as windbreaks, as cover crops, ornamental plants, and as fish poisons for light sticks, used in building huts, making charcoal, preparing gunpowder. |           | (Samajdar & Ghosh, 2017) (Gillett, 1963)         |
| The biomass of Sesbania sesban can produce wood within just 3-6 months when it grows with Cajanus cajan (leguminous) and used so as cooking fuel |           | (Adelanwa & Tijani, 2016)                       |
| Sesbania sesban is used in many African countries as a good source of fuel, grows fast, burns well, can be coppiced. It is used as fiber for ropes and fishing nets, and the seeds produce a gum. | Stem and thick branches Bark | (World Agroforestry Centre, 2002) |
| Sesbania grows in the salt-affected soils and limits the effect of salinity. Inoculating of Sesbania sesban with salinity-tolerant rhizobia under saline conditions increases biological nitrogen fixation | Whole tree | (Bakhoum et al., 2018) (Bala et al., 1990)       |
| Soil treatment laden with heavy metals                                      | Whole tree | (Gupta et al., 2011) (Dan and Hans, 2009)       |
| Green manure plants as Sesbania sp. combined with sewage sludge are an initial fertility driver for rapid increasing yield of maize, decreased salinity and pH, and increased organic carbon, nitrogen and phosphor concentrations in mudflat soil. | Whole tree | (Bai et al., 2017)                              |

**Phytochemical compounds of Sesbania tchadica (Sesbania sesban):** Sesbania tchadica (Sesbania sesban) has different chemical compounds that are, once extracted, very useful for treating diseases, manufacturing of drugs, organic or chemical supplements and antibacterial or antioxidant agents, manufacturing of biological manure, among others (Patra et al., 2006) ; (Kathiresh et al., 2012) (table 1). Details of phytochemicals compound combined with different extraction solvents are shown in Table 3.

**Table 3: Sesbania tchadica (Sesbania sesban):** Different Phytochemical compounds with the parts used and their extracts solvent.

| Phytochemicals compounds and parts used of Sesbania tchadica | Solvents | Extracts | References                        |
|-------------------------------------------------------------|----------|----------|-----------------------------------|
| Phytochemicals compounds and parts used of Sesbania tchadica |          |          |                                   |
(Sesbania sesban)

| Sterols, saponins, flavonoids | Methanol, Chloroform, Petroleum ether 60-80° | (Shaikh et al., 2012) |
|-----------------------------|---------------------------------|----------------------|
| Sterols, alkaloids. Fats and oil. Proteins, sterols, saponins, flavonoids, glycoside, vitamins sesbanins, sesbanimid phosphorus (Leaves). | Aqueous extracts | (Khare, 2007) |
| Campesterol, beta-sitosterol. (Pods, leaves). Cyanidin, delphinidin glucosides (Flowers). | Aqueous extracts | (Pandhare et al., 2011) (Ibrahim, 1992) |
| Triterpenoids, carbohydrates, vitamins, amino acids, proteins, tannins, saponin glycosides steroids (Leaves, seed) | Methanol | (Kathiresh M. et al., 2012) |
| Phenolics, anthocyanins, flavonoids (Flowers) | Ethanol Ether (diethyl ether) Chloroform (95% each one) | (Arif et al., 2013) |
| Steroids, Alkaloids. Reducing Sugars (carbohydrates), Tannins, Flavonoids, Saponin (Bark) | - | (Goswami et al., 2016) (Khare, 2007) |
| Cholesterol, campesterol and beta-sitosterol (Pods) | Alpha-ketoglutaric, oxaloacetic and pyruvic acids (Pollen and pollen tubes) | - | (Khare, 2007) |
| Crude protein and crude fiber (Dry matter of leaf) | Ethanol Ether and Chloroform. Ethyl acetate | (Siaw et al., 1993)(Kaitho, 1997) |
| Sterols, triterpenes. Flavonoids (Wood) | Petroleum ether and Chloroform. Ethyl acetate | (Nirmal et al., 2012) |

3- Discussion

Sesbania tchadica is a leguminous tree native to Chad that is used to increase crop yields and vegetation in some desert areas. The local population and particularly pastoralists plant it in arid zones to increase the plant cover, to obtain shade for humans and their animals and to use its wood for construction. The local population also uses Sesbania tchadica to enrich soil fertility for increasing yields of crops such as rice, maize and sorghum and to repel desert encroachment in zones with little vegetation (Ousman et al., 2017) (unpublished).

The author (Bashan et al., 2012) have demonstrated that native leguminous trees such as Sesbania tchadica are essential to ensure the revegetation of eroded desert lands and to restore eroded soil. These authors have also inoculated these leguminous trees with Plant Growth-Promoting Bacteria (PGPB) in agricultural and agroforestry systems. They planted a high density of these leguminous trees in certain areas with severely eroded soil and the result was a remarkable degree of revegetation and more stabilized soils. Sesbania tchadica can play an important role, along with other leguminous species, in land restoration and the protection and conservation of indigenous species in Chad (FAO, 2012).

In the present study, the authors found that most populations of Sesbania tchadica in N’Djamena are planted by the local population whereas in areas surrounding the city, most are wild (Jean and Cyrille, 2019). This suggests that the local population is aware of the importance of the species and wishes to benefit from its fast growth and its use for fuelwood, for improving soil fertility and for feeding and shading livestock. It measures approximately 4.5 meters in height in six months with a diameter of up to 12 cm (Shun-ching, 1960), (Anonymous, 1985), (Ousman et al., 2017) (unpublished). The average diameter growth measured in basal circumference is ranging from 16-28 cm (Shun-ching, 1960). In South of Morocco, to support the agriculture systems limited by the lack of water resources and disturbing salinization of surface or underground freshwater sources, the National Institute of Agronomic Research Institut National de la
Recherche Agronomique INRA has become interested in the adaptation of certain crops to saline environments and their contribution to improving food and fodder production in desert or arid areas. Successful results of resilient cultures and cover vegetation are obtained by the introduction of Sesbania sesban in a saline environment in the region of Laâyoune (INRA, 2019). Bala et al., (1990) found also that biological nitrogen fixation can be significantly increased by inoculating tree legumes such Sesbania sesban with salinity-tolerant rhizobia under saline conditions.

However, some important problems exist which threaten Sesbania tchadica and other leguminous trees in Chad. Robert & Mahamat Ali, (2005) pointed out that around cities such as N'djamena; the high demand for fuelwood threatens the sustainability of supply. Nwilo et al., (2020) noted that vegetation in the northwest and the northeast of Nigeria including the region of Lake Chad declined by 2.18% from 1984 to 2000 and by 2.02% from 2000–2016. The causes included agricultural activities such as extensive grazing, and annual cropping, other uses of the trees such as for fuelwood, charcoal, paneling and woodwork and variations in climate (Nwilo et al., 2020). Such exploitation poses risks to the conservation of the whole flora in these and other tropical and sub-tropical regions (Rukangira, 2001), (Ribeiro et al., 2017). Rukangira (2001) noted that policy makers, other stakeholders and citizens need to support conservation and help increase awareness of the problem. Moreover, effective strategies for biodiversity conservation should focus on regions with rare and endangered species, on locally abundant species that are functionally vital in maintaining the plant community and on regions with considerable heterogeneity of vegetation (Ribeiro et al., 2017). The collection of the plant material and the documentation, botanical identification and preparation of the herbarium vouchers are tasks that cannot be automated and thus require specialists who are becoming increasingly rare (Bucar et al., 2013); (Bruno et al., 2015).

In the current study, the species Sesbania tchadica was collected using standard procedures by Chadian expert foresters and botanists from the Toumai Institute and LRID Herbaria. Next, to identify the plant material, the authors used the empirical keys determination (leaves and pods forms, plant size, etc.). This determination is based on previous work of the botanist Léonard (Léonard, 1968) who did a collection of this species in the region of Lake Chad as part of a Belgian botanical expedition. This study also uses the plant illustrations of Sesbania sesban and Sesbania tchadica done by botanists Jean César and Cyrille Chatelain in their study of the Chadian flora (Jean and Cyrille, 2019). Jean and Cyrille (2019) explain that botanists who conduct research in Africa rarely have the opportunity to study the DNA of the plants they work on. For this reason, in the current study (as the Leonard and Jean & Cyrille studies), we have used the classical determination keys of Sesbania tchadica, (as cited above). This allows a more logical hierarchy of groups based on morphological characters, which are really the only ones accessible to the field botanist.

4- Conclusion

The ethnobotanical study carried out specifically from N'djamena region and its surroundings allowed the authors to assess at the local level an important tree and shrub species, Sesbania tchadica (Sesbania Sesban). Sesbania tchadica leaves were harvested and organized according to a morphological model in order to facilitate its identification. However, this morphological and descriptive study conducted on Sesbania tchadica proved to be very complex because the exploitation of data at local level still less-exploited. As a result, this paper contributes to the production and maintenance of a new database on this species. It is also a gain for the scientific world and the research organizations in Chad and internationally. This study will hopefully contribute to the protection, use and value of Sesbania tchadica.

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Declarations

Ethics approval and consent to participate: The manuscript is not submitted to other journal for simultaneous consideration. The work is original and has not been published elsewhere in any form or language. Authors adhere to discipline-specific rules for acquiring, selecting and processing data.

Compliance with ethical standards

Competing interests: The authors have no relevant financial or non-financial interests to disclose.

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Availability of data and materials: The data that support the findings of this study are available from the corresponding author upon reasonable request. All data relating to this species generated during the study survey are included in this paper. A voucher specimen is deposited of the Toumaï Institute and IRED herbaria (Chad) and then in the Applied Biology and Pathology Laboratory Herbarium (Morocco).

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