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Cleome droserifolia: An Egyptian Natural Heritage Facing Extinction

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ABSTRACT

A review is given regarding the studies that have been carried out on the medicinal plant Cleome droserifolia, commonly known as spider flower. It covers the plant's systematic, morphology, ecology and geographic distribution in Egypt. The target species is a perennial aromatic shrub of the family Cleomaceae that requires stony soil for growth, it's distributed regionally in Egypt, Libya, Syria, Jordan and Palestine, in Egypt it appears in South Sinai, Red sea coast, the Oasis and Mediterranean coast. The review demonstrates several phytochemical properties of Cleome droserifolia (Forssk.) that revealed its antihyperglycemic, anticancer and antibacterial properties along with many terpenoids and flavonoids. Moreover, the herb Cleome droserifolia is wildly known in the Egyptian folk medicine for treating several fatigues and diseases. Therefore, C. droserifolia is under the stress of intensive harvesting for traditional medicine, trade and research use that has led to severe depletion of its population. This review is targeting the conservation ecology of Cleome droserifolia (Forssk.) through better understanding of the diversity of the species in a community or a region, ecosystem processes, temporal and spatial variability of its environment, historical contingency and evolutionary processes. Cleome droserifolia, one of the most valuable medicinal plants in Egypt that needs to be treasured.

Keywords: Spider Flower, Conservation, Medicinal Plants, Antidiabetics, Anticancer, Hepatoprotective, Allelopathy, Taxonomy.

INTRODUCTION

In an overpopulating world consuming every last resource on God's green earth- conservation is a must. In the past 50 years, the concern with resources management has been growing and conservational strategies have been emphasized to conserving ecosystems, developing a better understanding of how they interact as Pickett et al. [1] suggested that one does not conserve vegetation which is a thing but rather one is attempting to conserve a dynamic. Egypt due to its strategic location at the junction of four bio-geographical regions is home to a wide variety of flora. Medicinal plants in Egypt have been part of the country's natural and cultural heritage for thousands of years. However, many species are threatened due to human impacts, loss of natural habitat or overexploitation [2,3]. The family Cleomaceae is a small family of flowering plants in the order Brassicales, comprising more than 300 species belonging to nine genera of which Cleome is the largest genus with about 180 - 200 species of medicinal, traditional and ecological importance [4]. It is represented in the wild Egyptian flora by two genera and ten species of wide ecological and geographical range of distribution [5]. *C.droserifolia* (Forssk.) Delile Descr. (syn. Roridula droserifolia Forssk.); the most famous species among the genus Cleome in Egypt, Perennial aromatic shrub characterized by its orbicular leaves, it grows in Egypt, Libya, Palestine and Syria as it requires a stony and sandy soil [6]. It is known in Egypt as Samwah [7]. This plant has a great fame as an antihyperglycemic agent [8-10] and used by herbalists in Egypt as a hypoglycemic agent, plus it's widely used by the Bedouins of the southern Sinai for treating diabetes [8]. It has been

uprooted extensively from vast areas, especially in the Sinai and the Eastern Deserts, to the extent that endangered its existence. However, it still thriving in the far south of the Eastern Desert Batanouny et al. [2,11]. The present review describes the available literature on the conservational status, of *C. droserifolia* (Forssk.) Delile, It covers the taxonomy, morphology, geographical distribution and ecology molecular studies and pharmacological approaches of the plant. In addition it investigates the potential threats endangering its population, discussing the most suitable conservation actions to end the risk of extinction.

TAXONOMY

There has been a long debate on whether the genus Cleome belongs to the family Cleomaceae or Capparaceae. Historically, it has been treated as a subfamily of Capparaceae [12]. Molecular and morphological data has been used to solve this confusion. Kamel et al. [13] presented a study that suggests separating Cleomaceae as a distinct family from Capparaceae using the morphological descriptions of a large amount of herbarium materials of the Egyptian Cleomaceae. While, some taxonomist hall [14-16] have used molecular data to settle the monophyly of Cleomaceae. They illustrated that, Cleomaceae are easily distinguished from closely related Capparaceae and Brassicaceae by their mostly herbaceous habit, palmately compound leaves, capsular fruits lacking a septum, and seeds with a testa that has a pronounced invagination [14,17]. Members of the family also have distinctive monosymmetric flowers with a ground plan of four sepals, four petals, generally six stamens, and a bicarpellate gynoecium. Floral monosymmetry arises through upwards curvature of corolla and androecial whorls, which may be complemented by shape, size and color differences between adaxial and abaxial petals as well as variation in nectar gland shape [18,19].

MORPHOLOGY

C. droserifolia is a perennial, low aromatic cushion like shrubs of 25 to 60 cm length (Figure 1). Stems are intricately branched, carrying broad oval shaped leaves. The leaves are three nerved, thick and carrying swelled glandular hairs. Flowers blossom in the axils of the upper leaves, they are one to one and half centimeter long bearing four to eight dimorphic lanceolate sepals of 1-2 mm, petals are greenish yellow, appendiculate and dimorphic consists of two broad and two narrow, have four stamens (Figure 2) The fruit is 0.3 to 0.4 cm and erect, while the seeds are smooth and glabrous of no more than one centimeter in length Batanouny et al. [11].

Figure 1: Photo of Cleome droserifolia shrub taken in Saint Cathrine protectorate by A.A. Moustafa.

Figure 2: Map representing the geographic distribution of Cleome droserifolia in Egypt.

GEOGRAPHICAL DISTRIBUTION

The geographical distribution and occurrence of the Family Cleomaceae in the wild flora of Egypt vary greatly among species (Figure 3). Kamel et al. [13] have pointed that certain species were attributed to certain phytogeographical territory; *C. hanburyana* was confind to Gebel Elba, *C. amblyocarpa* and *C. arabica* were widespread in the Mediterranean, Nile delta, Sinai, along the Red Sea coast and Oases, while *C. brachyacarap*, *C. scaposa, C. paradoxa* and *Dipterigium glaucum* were only distributed in the western desert Red sea coast and Gebel Elba region.

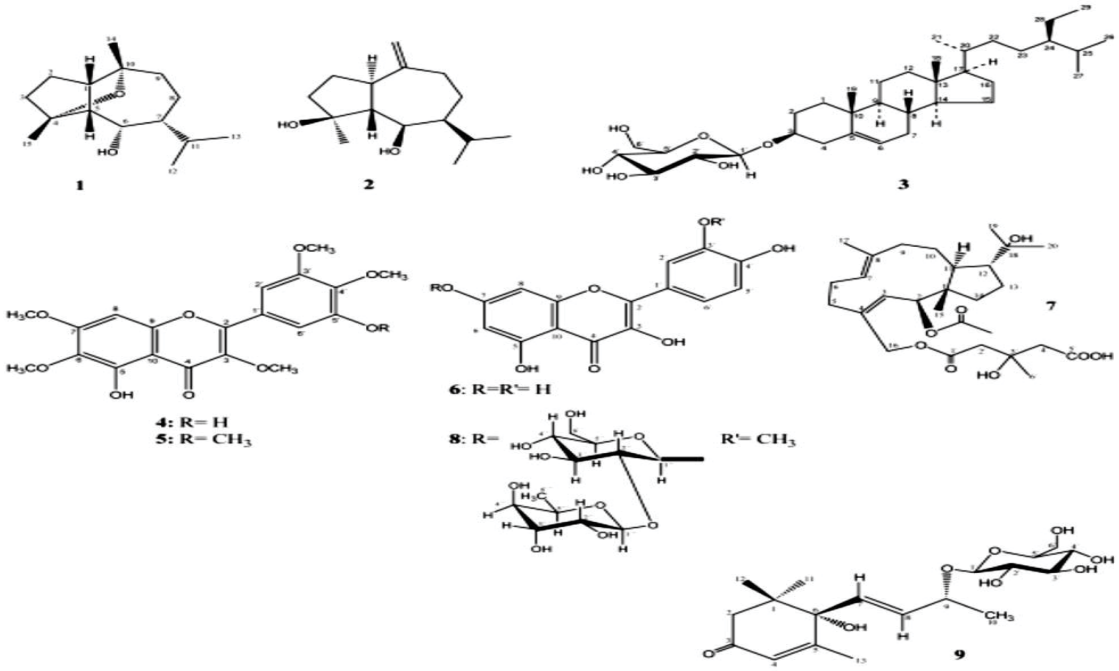

Figure 3: The structure of hepatoprotective compounds isolated from Cleome.

C. droserifolia community was reported in El Galata and El Bahariya by Kassas and Zahran [20] and in south Sinai,

specifically in wadi Meir, Umm Shomer, wadi El-Kid, wadi Isla and wadi Zaghra Kamel and Moustafa [2,21-23]. recorded C. droserifolia in three wadies in Saint Cathrine, wadi el Tarfa, wadi Isla and wadi Hebran. Meanwhile Salama et al. [24] recorded an occasional occurance of *C. droserifolia* in three out of four stations in South of the Eastern Desert, Egypt. Their study area covered three desert types: The limestone desert (Assuit- Qena Desert), the sandstone desert (Idfu-Kom Ombo Desert) and the Red sea coastal plain Zahran and Willis [25]. The *C. droserifolia* wasn't recorded in the Idfu marsa alam transect probably due to the sandy nature of the region.

ECOLOGY

The ecology of C. droserifolia was dealt with in a very limited number of studies, Moustafa and Kamel [21] have mentioned that C. droserifolia preferred the gentle slopes with depressions, vast wadis and low terraces of South Eastern Sinai. While, Dargie and El Demerdash [26] described the plant among those which preferred wet wadis and coarse-textured stony soil with stone surface.In a location 40 miles near Kattamia station Eastern desert Hegazi [27] has studied the population of *C. droserifolia*, he notified that the soil was rocky calcareous with 28% carbonate content and alkalinity of 7.8 while the precipitation ranged from 25 mm/y to 55 mm/y at maximum. In his study area, the *C. droserifolia* dominated the community with importance value of 67.8 out of total 300, followed by *Zygophyllum decumbens*, Launaea spinosa and Gymnocarpos decandrum, along with some other species of lower importance value forming the associated vegetation in the population. His investigations of the seed population demonstrated that the largest ratio of seeds was endogenously dormant 44.2%, and only 8.9% had exogenous dormancy, while the rest of the seeds were non-viable. The increased dormancy was attributed to the arid environment conditions and the stresses caused by lack of water and elevated temperatures added that seeds showed short distance dispersal; one meter away from the parent plant related to the nonviolent capsule dehiscence, which as a result, increases the chance of falling seeds to meet favorable germination conditions- being fell in the same spot of the parent plant. Adult plants had higher survival more than seedlings and juveniles due to the development of deeper root system thus more water access. Adults represented the greater ratio of the population. According to the study, C. droserifolia keeps vegetating all year round, leafing reaches a peak in April, flowering and fruiting extends from early May until early October Hegazy and Fadl-Allah [27].

CONSERVATION STATUS

Generally speaking, the major causes threatening most of the medicinal plants are natural due to aridity and irregularity of rainfall. However, the effect of human impact is always more destructive [2]. The species is threatened because of ecological disasters such as several successive seasons with lower than average precipitation and over exploitation of mature plants by desert dwellers and herbalists in folk medicine [28]. Overcollection for trade home use and research purposes are the main anthropogenic causes that led to endangering *C. droserifolia,* followed by low levels of stress due to grazing in Saint Cathrine protectorate [2]. The plant has been eradicated from vast areas in Sinai and the Eastern Desert. However in the far south of the Eastern Desert the plant is still flourishing and is growing in many wadis in hot desert areas Batanouny et al.[11]. Floristic analysis by Salama et al. [29] in wadi Qena disclosed the disappearance of *C. droserifolia* among other species after being recorded in a previous study, they attributed that to the human activity in the study area.

TRADITIONAL AND MEDICINAL IMPORTANCE

Medicinal plants are the future of manufacturing drugs. *C. droserifolia* herb is well known in the Egyptian folk medicine for treating diabetes, stomach ache, skin allergies and open wounds. That has driven the attention to its potential phytochemical properties among researchers. In the last twenty years, various number of studies have been done on *C. droserifolia*, testing its different medicinal properties, the resulting outcomes were remarkable.In their search for medicinal plants with anticancer properties Ezzat and Abdel Motaal [30] have isolated new cytotoxic metabolites from *C. droserifolia*, that showed significant cytotoxic activities against two tested cell lines in comparison to those of the anticancer drug doxorubicin. In addition the plant has shown strong antidiabetic and antioxidant properties plus the ability to regulate blood insulin, the aqueous extract contained very high percent of the total active flavonol glycosides that when tested at different doses showed a 63.3% activity similar to that of the commercially used metformin [10,31,32]. Furthermore Abdel-kader et al. [33] have tested significant hepatoprotective effects of *C. droserifolia*

aerial parts extract. An anti-schistosomasis activity of *C. droserifolia* has been detected by El-Shenawy et al. [34]. They found that the plant extract has beneficial effects on thyroid hormones status, its direct effect on the parasite, and its enhancing effects on antioxidant capacity of the host. Several sesquiterpenes, steroids and flavonoids have been isolated from *C. droserifolia* [35-37].

PHYSIOLOGICAL STUDIES

The allelopathic effects of C. droserifolia shoot extract was tested on its seed germination and seedling growth as well as the mycoflora in the soil. The study showed negative effect of the shoot extract on seed germination and seedling growth indicating that *C.droserifolia* is autotoxic. Regarding the *Mycoflora*, the two species *Penicillium chrysogenum* and *Penicillium funiculosum* were most sensitive to the allelopathic effects of *C. droserifolia*. Meanwhile, *Rhizopus stolonifer* was the only isolated species found to be resistant to the allelopathic effects Hegazy and Fadl-Allah [27,38,]. Developed heterotrophic callus cultures and photomixotrophic cultures from whole seedlings of *C. droserifolia* and studied the effect of light and dark conditions on them to find that the heterotrophic callus cultures excreted allelochemicals (autotoxic) which inhibited callus induction and development. Badri et al. [39] determined the mineral composition (Ca, Mg, K, Na, Fe, Al, Mn, Co, Ni, Cu and Zn) of Senna alexandrina and *C. droserifolia* in the Eastern Desert of Egypt. It was found that the concentration of Fe, Al, Mn, Co, Ni, Na and Si in the leaves of Cleome was always higher than that in the leaves of Senna. Eventually, Salama and Fayed [40] carried out phyto-sociological studies of thirty-nine species including *C. droserifolia* for comprising the vegetation of wadi qena using the zurich montpelliar technique.

MOLECULAR STUDIES

Not too many molecular studies have been carried out on *C. droserifolia*, although the field of molecular data has been of great importance regarding the taxonomy studies of the family Cleomaceae. El-Domyati et al. [41] have used molecular markers such as RAPD (Random Amplification of Polymorphic DNA), ISSR (Inter Simple Sequence Repeats) and AFLP

(Amplified fragment length polymorphism) "techniques" to detect genetic diversity of medicinal plants selection including *C. droserifolia*. The study showed that taxonomical locations can be distinguished for each subspecies with as low as 0 to 1% polymorphism using AMOVA (Analysis of Molecular Variance) analysis, but it cannot be recognized as a different subspecies. El-Atroush et al. [42], tested the identification of C. droserifolia as a medicinal endangered plant using two DNA barcoding regions (ITS and rbcL). It was found that ITS would be very useful for the barcoding of some medicinal endangered plant species, where it has a better resolution toward species identification.

STRATEGIES FOR CONSERVATION

As a population *C. droserifolia* has the potential to remain stable for several reasons firstly the species forms a coenopopulation including all phases of the life cycle from seed to senescing individuals. Secondly the cushion habit of the species makes it possible to sort the population into different age classes. Which was the case when Hegazy [27], had investigated a C. droserifolia population near Kattamia station in the Eastern Desert, he also observed that the oldest age class was only 0.5% of the adults, which insures high productivity. The coarse-grained soil guarantees moisture availability, meaning that, a cover of cobbles and stones would conserve more moisture than a cover of gravels Hillel and Tadmor [43]. Furthermore the investigated population was isolated and has no sign of disturbance or human impact. Studies recommended several strategies for conservation; Hegazy [27] suggested that, some populations should be conserved in situ and protected from human activities harvesting should be restricted to the oldest individuals in the population vegetation propagation by creating optimum conditions for flowering seed setting and seedling establishment more experimental research and seed storage techniques should be presented. Moreover Abdelwahab et al. [2] emphasized that providing detailed databases about productivity, biomass and reproductive ecology, can help evaluate the ecological status of the plant along with detailed mapping and spatial distribution for *in situ* conservation. Establishing herbaria, botanical gardens and gene banks for the endangered plant is a strategy for *ex-situ* conservation. Besides the sustainable use of medicinal plants by increasing the awareness of herbalists training indigenous Bedouin and involving them in conservation process would be of great support of the conservation process. From the previous literature, it's obvious how valuable *C. droserifolia* is, although it's shocking how sparse and ancient the ecological

studies that has been done on the species in relation to its significance as a medical plant. The plant's population ecology had only been studied in detail once in one location over a decade ago. Although the study had recorded no disturbance, the intense invasion of urbanization in the Egyptian deserts nowadays must have destroyed every wild life left. Other ecological studies only referred to it either as a count or reported its presence. *C. droserifolia* has been known to have important medicinal properties and very useful to indigenous Bedouins for traditional remedies and consequently the major reason for the plant to be endangered is the overcollection for medicine and research. Thus it is crucial to carry out intensive population ecology studies targeting the plant distribution studying its growth forms over seasons managing to establish gene bank and testing its capability of cultivation.

CONSERVATION PLAN

Nature conservation has changed from an idealistic philosophy to a serious technology Harper [44]. Using new biotechnologies such as molecular markers to study the genetic diversity of endangered plants is remarkable. As well as molecular data has resolved the systematic dilemma of the family Cleomaceae. *C. droserifolia* an endangered plant famous for its significant biomedical properties. Therefore implementing long term conservation program is a priority. The plant protection could be fulfilled through sufficiently studied autecology considering its propagation as a mean of ecosystem rehabilitation raising public awareness since overcutting is the main stressor causing Cleome depletion. Furthermore governmental environmental organizations and authorities must be involved ensuring that protecting *C.droserifolia* is a national duty. There is a need to work in different directions to protect this species from extinction: conservation through create genome resource bank and build-up of seed banks that can act as reservoirs of genetic variation, thus delaying the loss of genetic variation and maintaining the evolutionary potential of populations It is by Zaghloul [45] it is necessary to carry out regular monitoring to keep updated on the population size distribution and its trends [46].

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