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Biology, ecology, and uses of the medicinal plant *Sesamum alatum*

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Abstract

Introduction: *Sesamum alatum* is a herb, sometimes considered a weed, common in African and Asian countries. It is used as a food and medicine but receives little attention in the scientific literature. Therefore, studying it for more effective and sustainable use is essential.

Objective: To describe biological, geo-ecological, cultivation, and utilization features of *S. alatum*.

Review methods: The study reviewed material from the online catalog JSTOR Global Plants, scientific articles, and other scholarly sources. It was conducted in Atlas.ti using the codes "description," "taxonomy," "ecology and distribution," "production," "food value," and "medicinal value." Then, the resulting quotes were compiled into coherent text.

Results: *S. alatum* is an erect, herbaceous plant with lanceolate leaves, pentameric flowers with spotted reddish colors, elongated capsular fruit, and dark-winged seeds. The plant occurs in savannas, villages, or roadsides of tropical Africa, the Near East, and Tamil Nadu. Some rural communities grow the plant, and the hybrid *S. alatum* × *S. indicum* increases sesame's resistance to phyllodes. Leaves and seed oil have culinary and medicinal values. *S. alatum* inhibits the growth of *Escherichia coli*, *Pseudomonas cepacia,* and *Staphylococcus epidermis*, exhibits antidiabetic, antinephropic, antidiarrheal, and aphrodisiac properties, and helps treat infertility in women and cattle.

Conclusions: A cost–benefit analysis for the use of *S. alatum* as a food and plant therapeutic resource suggests that it would be unwise not to harness it, considering its high level of spontaneous anthropogenic dissemination, its nutritional value, potential as an antimicrobial, antidiarrheal, and antidiabetic agent, and evidence of its benefits in sexual and reproductive health.

Keywords: *Sesamum alatum, biology, ecology, nutritional value, medicinal value*

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1. Introduction

Sesamum alatum is a plant species endemic to Mozambique and other African [1] and Asian countries [2, 3]. It is phylogenetically close to *Sesamum indicum*, or sesame, but does not have the same commercial value. *S. alatum* is traditionally used for gastronomic and medicinal purposes in African countries [4] and India [5], showing great potential if it receives proper attention from researchers and industry. In addition to knowledge passed down through oral tradition, studies confirm its high food and therapeutic values [2, 3], but these appear sporadic, and there is a need for a coherent body of theoretical knowledge to inform the engagement of future researchers.

The health sector in Mozambique faces many challenges, among them ensuring food and nutritional security and access to medicines for infectious and non-communicable diseases, especially for rural populations [6]. Most medicines come from other countries, and there are other obstacles, such as their high cost or the onerous logistics involved in distribution. On the other hand, Mozambique has about 5500 plant species with phototherapeutic potential and even ethnobotanical use [7]. The investment for the sustainable harnessing of Mozambican biodiversity to mitigate gaps in the availability of medicines would considerably alleviate the National Health System and enrich the national repertoire of alternative cures for the predominant diseases in the country. Studying *S. alatum* and other medicinal plants will open doors to a very fertile field of research.

This article aims to describe the main biological, ecological, and geographic aspects of the cultivation and use of *S. alatum* for gastronomic and medicinal purposes. This is one of the few scientific articles with in-depth, comprehensive, solid, and updated information.

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2. Methodological approach

The present analysis was based on a review of herbaria, scientific articles, and other scholarly documents on *S. alatum* available in the literature. Sources were searched on Google Academic (https://scholar.google.com) using the term "*Sesamum alatum*." Initially, only documents that contained the name in the title were selected, but a snowballing process based on the content of the found documents allowed more documents to be found about it. Textual analysis was done in Atlas.ti using the codes "description," "taxonomy," "ecology and distribution," "production," "food value," and "medicinal value." The citations were then selected and organized into a coherent text, and finally discussed based on further information from the scientific literature.

3. Biology and ecology

3.1. Description

S. alatum (**Figure 1**) is a tall, erect, grooved annual herbaceous plant [2, 3, 8–10], 20–150 cm tall [2, 3, 9, 11], often 20–90 cm [9], being among the few species of the genus *Sesamum* with winged seeds [8, 12].

Figure 1 • ***Sesamum alatum***. Fonte: Dupont [13], under the Creative Commons Attribution-Share Alike 2.0 Generic license.

The stem is drooping and initially very glandular [14], and it has a green pigmentation with a little purple mixture [15]. It is simple, sporadically branched, and glabrous but contains mucilaginous glands [11].

The leaves are usually heteromorphic, opposite [2, 9, 11], and sometimes alternated [2, 9]. The lower leaves are petiolate, 2–7.5 cm long, palmately, tri- to pentafoliolate or highly divided with narrow, linear-lanceolate lobes (8 × 2 cm each) [2, 9, 15], with an often undulating but sometimes entire margin [2, 9, 11]; the central lobe being generally more extended than others, with a cuneiform base [2, 9] but sharp or rounded at the apex [9]. The upper leaves are simple, with an entire margin, 3.5–10 cm long [2, 11], and glabrous, except for the mucilaginous glands, which are denser underneath [2]. The leaves have no stipules, and the petioles are 1–7 cm long [11].

The flowers are pedicellate, tetracyclic, pentamerous (except for the gynoecium, described below) [16] and solitary in the leaf axils, are bisexual, zygomorphic, and pentamerous, with a short pedicel and nectar at the base [11]. The typical diameter of each flower is 3.5 cm [2]. The calyx is gamosepalous with valvular aestivation [16], campanulate, narrowly rectangular lobes, densely glandular, deciduous, and linear-lanceolate, acuminate lobes, about 3.5 mm long, pubescent on the outside [2, 11].

The corolla is pink, light reddish, purple, or brownish [2, 14, 15], gamopetalous [16], sometimes with red spots inside, may reach 3.5 cm long, obliquely positioned and contracted at the base, with three imbricate aestivation subglacial limbs [2, 16] and four extra-floral, slightly pubescent, glandular nectaries on the outside [2]. The base is fleshy and conspicuous [11]. The androecium consists of four epipetalous fertile stamens with posterior staminode [2, 11, 16], each stamen having a multicellular gland at its tip [16].

The gynoecium is syncarpate, comprising a slightly inclined (5 × 1 mm), ascending, pubescent ovary [2, 11, 16] containing two carpels with several ovules [16]. The single stipe is slender and dilated at the apex [2], terminating in a bilobular stigma [16].

The fruit, initially very light green [17], little beaked capsule [2, 11, 15], is described as an obconic or cylindrical [15] 2–5 cm long and 0.7 wide [2, 11], forked [15], with 5–13 mm long beaks and two locules separated by a false septum; the fruit being glandular and slightly pubescent, becoming glabrous at maturity, containing four grooves [2].

The seeds are obliquely overlapping in the capsule [9], being black [5] or dark brownish and wrinkled [15], winged obconical [2, 8, 11, 12] at both ends, 2–3 mm long, faveolate, suborbicular, 2–3 mm long [2, 9, 18]. Besides the large wings, there are two smaller subcircular wings at the base, pale to dark brown [11, 18].

3.2. Taxonomy and nomenclature

The present classification is based on Kirby [19] and Chapano and Mugarisanwa [20], with readjustments based on the United States Department of Agriculture (USDA) [21] and other available literature. The *S. alatum* commonly described in the

literature is the Gold Coast type, identified by Thonning (or Thonn., Holo. C). It belongs to the domain Eukarya, kingdom Plantae, subkingdom Tracheobionta, super division Spermatophyta, division Magnoliophyta, class Magnoliopsida, subclass Asteriidae, order Scrophulariales, family Pedaliaceae [3, 5, 19–21], section *Sesamopteris* Endl. [4], and genus *Sesamum* L. [21]. The variety found in Mozambique is *S. alatum* var. Sambesiacum, whose sample was preserved in the herbarium at the University of Vienna and was collected in Boroma (in Zambezia, Mozambique) by Menyhárt [22] in 1891.

Other scientific names of *S. alatum* are *Sesamopteris alata* Thonn. DC., *S. ekambaramii* Naidu, *S. gracile* Endl., *S. pterospermum* R. Br., *S. rostratum* Hochst., *S. sabulosum* A. Chev., *Simsimum rostratum* Bernh. [18, 23, 24], and *Volkameria alata* O. Ktze [2, 9].

S. alatum throughout most of Africa seems reflected in many names (**Table 1**). The close relative *S. indicum* is known as "sesame" or "sesame" in the Portuguese language [25], so it is not surprising if the same name is given to *S. alatum*. For example, the name in English means "winged-seed sesame."

Table 1 • Vernacular names of *Sesamum alatum* in some African countries, according to the literature

Name	Language	Country
Guzozo	Shona	Mozambique, Zimbabwe
Sesame winged-seed	English	Zimbabwe
Namt	Fula-Fulfulde	Burkina Faso
Bénéfin	Manding Bambara	Senegal
Ngulok	Serer	Senegal
Well	Fula Pulaar	Senegal
Béré, *habeta* or *yorholan*	Wolof	Senegal
Tacuta	Songhai	Mali

Sources: adapted from JSTOR Global Plants [1] e Hyde, Wursten [23].

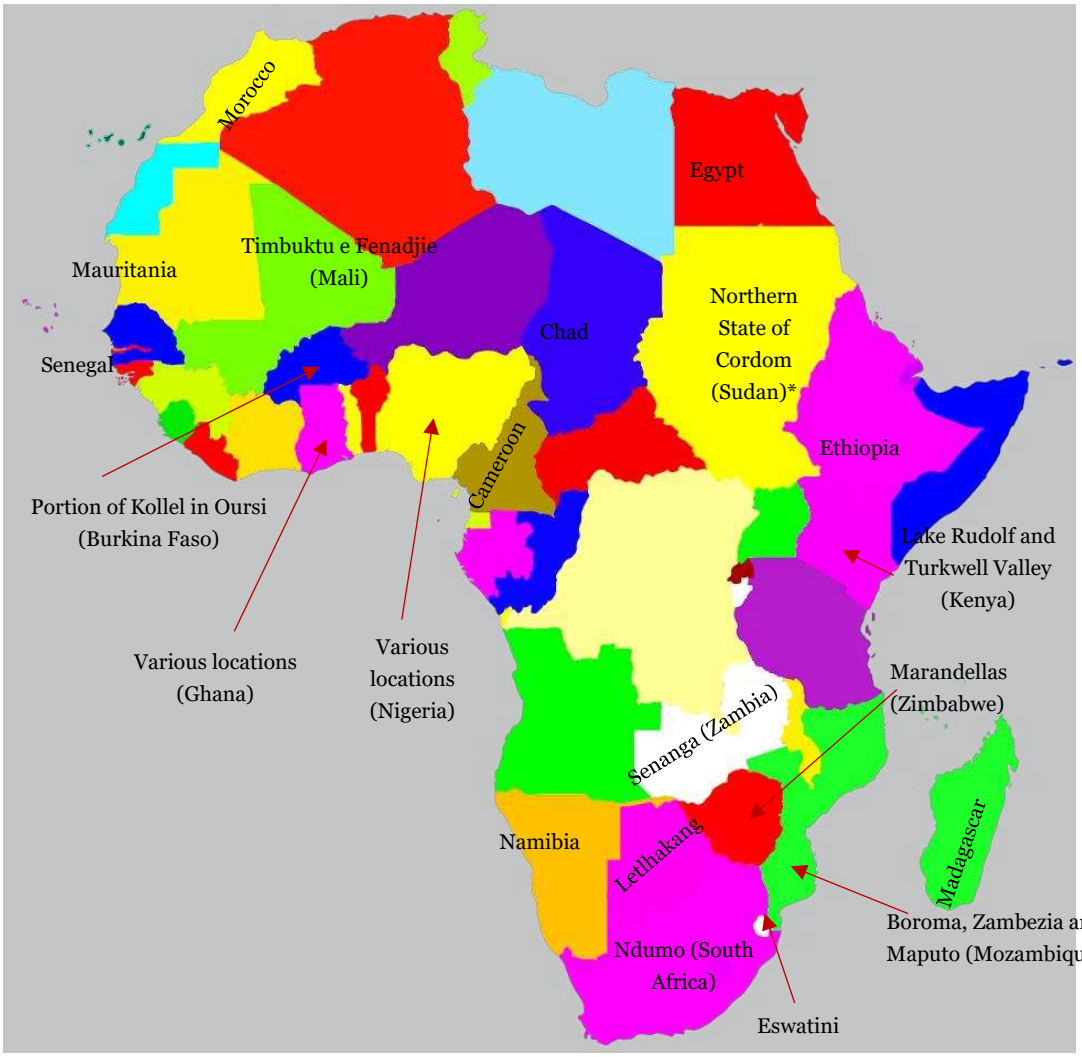

Figure 2 • The countries or localities marked represent locations on the African continent where specimens of *Sesamum alatum* were reported in the literature. *There was no separation between North and South Sudan. Based on Braxmeier, Steinberger [26] map, under simplified Pixabay license (free for commercial use, unnecessary assignment), with data based on Kotschy [24], Bruce [9], Hutchinson and Dalziel [14], Daramola [17], Kamal-Eldin and Yousif [12], Potterat, Hostettmann [4], Mariod, Saeed Mirghani [11], Menyhárt [22], Ihlenfeldt [18], and Dehn [27].

Table 2 • Some specimens of *Sesamum alatum* from different African countries in herbaria

Year	Country	Locality	Collector	Herbarium
1839	Sudan*	Mount Arasch-Cool, Kordom	Kotschy [24]	Royal Botanic Gardens
1891	Mozambique	Boroma, Zambezia	Menyhárt [22]	Universität Wien (WU)
1953	Kenya	Lake Rudolf/Turkwell Valley	Bruce [9]	Royal Botanic Gardens
1968	Nigeria	6 km from Daura	Daramola [17]	Forestry Research Institute of Nigeria

* The data predates the separation between North and South Sudan.

3.3. Ecology and geographical distribution

S. alatum grows on sandy soils [17, 18] of dry savannas, grasslands, or riverbeds as a tropical wild grass [4, 18], sometimes at altitudes as high as 600–900 m [9], present in Africa [4, 10, 11], the Middle East [2], and Indian Subcontinent [3]. It is often considered a weed [8], with anthropogenic tendencies, appearing spontaneously in villages [10, 14] or sometimes on roadsides [23].

The JSTOR Global Plants [1] database has information on the location of *S. alatum* specimens (**Table 2**). The most significant herbaria include specimens from distant and distinct areas, suggesting that the plant is endemic to much of the African continent. Several authors [2, 4, 11] confirm that *S. alatum* occurs throughout tropical Africa.

Figure 2 shows the areas already mentioned and others where specimens were collected for herbaria and other scientific purposes. Outside Africa, *S. alatum* has been observed or collected in other regions bordering the Indian Ocean. In a biodiversity study, Mashrahi, Al-Huqail [2] identified *S. alatum* among plant species from the Tihama region (17°18′152″N, 42°50′297″E), belonging to the southwestern province of Jazan. Further away from Africa, Kamal-Eldin and Yousif [12] collected samples in Salem and the adjacent districts of Tamil Nadu, India, to study its antibacterial activity.

Considering the areas where the plant occurs, it seems reasonable to deduce that it may be present in Yemen, Oman, the United Arab Emirates, Iran, Pakistan, and even Sri Lanka.

4. Cultivation

In some places, *S. alatum* is unwanted and eliminated as a weed, but there are communities that not only allow it to grow but also cultivate it as a source of nutrients or for medicinal purposes [11]. The genetically related species *S. indicum*—both having $2n = 26$ [28]—is a commercial source of sesame, and *S. alatum* is more resistant to phyllode [15, 29–31], a viral disease that causes abnormal development of flower components, resulting in the annual loss of 15% of production [32]. *S. alatum*, with 528.41 Mb, has a larger genome size than *S. indicum* [28], and it might imply superior and untapped genetic potential (e.g., metabolic range), although it requires further studies.

According to Ramalingam, Prabakaran [15], the two species were hybridized to increase sesame production. Rajeswari, Thiruvengadam [30] added that chemical and cytological analyses of hybrids of *S. alatum* and *S. indicum* from greenhouses showed considerable resistance to the phyllode. The same authors said that large parts of the phenotypic characteristics of the hybrids are intermediate between the two species, meaning that *S. alatum* may have lost phyllode resistance but may have developed more commercially viable offspring.

Thus, if *S. alatum* is to be grown for pharmaceuticals or even food production on a commercial scale, it is worth comparing it with the *S. alatum* x *S. indicum* hybrid first and checking which of the two is more cost-effective.

5. Uses

The appearance of *S. alatum*, considering its palmate lower leaves, with a bright greenish color, with pubescent parts and brightly colored flowers, gives the plant an appearance suitable for ornamental purposes, an aspect confirmed by Burkill [10] in their herbarium descriptions. In addition, some communities use *S. alatum* as a source of food or medicine.

5.1. *S. alatum* as food

In their catalog *Useful Plants of West Tropical Africa*, Burkill [10] reported *S. alatum* leaves and seeds as food. Sundarakumar and Karmegam [3] described in more detail the use of *S. alatum* for food, explaining that besides being a source of lipids, it has antioxidant properties and is a safe food to eat. The authors recommended *S. alatum* as an alternative in rural communities.

In Sudan and Chad, the leaves and new shoots are cooked as vegetables and sometimes seasoned with crushed seeds. Some Sudanese communities eat the fruit and use it for oil production. The seeds are a source of oil—according to Mariod and Matthäus [8], making up 28.9% of the seed—and valuable for culinary purposes (**Table 3**), but sometimes people cook and eat alone or with pumpkin leaves and rice or other staple food. Sometimes, the seeds are ground to produce flour used in soups.

Table 3 • Composition of 100 g oil from the seed of *Sesamum alatum*

Compound	Quantity (%)
Oleic acid	45.1
Linolenic acid	36.3
Palmitic acid	10.9
Unsaponifiable*	0.78

* Tocopherols, 2-episesalatine, sesamin, sesamolin, and sterols.

Source: Adapted from Mariod, Saeed Mirghani [11].

5.2. Medicinal value

Table 4 presents substances obtained from *S. alatum* and their phototherapeutic potential. The information suggests that *S. alatum* may contribute to treating infectious, non-communicable diseases or as a stimulant for other desirable effects.

Sundarakumar and Karmegam [3] demonstrated that the leaf extract in ethanol could inhibit the growth and vigor of *Escherichia coli*, *Pseudomonas cepacia*, and *Staphylococcus epidermis*. The authors added that this experiment is a good starting point for identifying the antimicrobial principle of the extract.

Ayurveda, a 3000-year-old Indian system of natural medicine, uses *S. alatum* as a treatment for diabetes and kidney disease [5], which suggests that knowledge about the use of the plant for such purposes may be ancient and thus well-known to some communities in the Indian Subcontinent. The experience of Idenyi et al. [33] in rats supports the idea of *S. alatum* antidiabetic potential. Ellandala et al. [5] and Idenyi et al. [33] recommend the continuation of their studies to isolate the active compounds that confer antidiabetic potential to the plant.

S. alatum has also been used for sexual and reproductive health. In Senegal, traditional doctors use it to treat female sterility [4]. In Sudan and Chad, infusions serve the same purpose for cattle [11]. As mentioned in **Table 4**, the seed is an aphrodisiac. These sexual and reproductive health benefits require further research to clarify the level of effectiveness.

Table 4 • Bioactive compounds and extracts from *Sesamum alatum* and their medicinal value

Plant component	Substance	Medicinal value	Sources
Aerial parts	Verbascoside	Renal protection and antidiabetic activity	Sundarakumar and Karmegam [3]
Leaves	Ethanol extract	Antimicrobial activity	
Seeds	Unspecified	Renal protection	Ellandala et al. [5]
Leaf	Malonic extract *	Attenuation of diabetic nephropathy (antioxidant) **	
Seeds	Oil	Aphrodisiac and antidiarrheic	Mariod, Saeed Mirghani [11]
Leaves	Powdered, mixed with feed	Relief of oxidative stress associated with diabetes	Idenyi et al. [33]

* 300 mg/kg body mass.

** Experimented in rats.

6. Conclusion

S. alatum probably proliferates in tropical areas, considering its anthropogenic dispersal throughout Africa, the Middle East, and the Indian Subcontinent. Its natural resistance to phyllodes and tiny, winged seeds facilitate wind dissemination. To the layman, *S. alatum* appears to be a plant whose benefits are unknown, underestimated, or neglected in favor of others much better established for nutritional or medicinal value. Still, there is scientific literature, traditions throughout Africa and Asia, and evidence of its nutritional and medicinal values. The most commonly used parts are the leaves and seeds, sometimes the fruits. The antimicrobial potential can be harnessed, and it might be worth studying how *S. alatum* can help with fertility or as an aphrodisiac. However, this plant's most significant value lies in the seed oil and antioxidants as supplements for food in rural communities and, above all, the antidiabetic properties. It is essential to find the active compounds and see if the good results observed in animal studies apply to humans. Following current trends, *S. alatum* has strong potential as a nutraceutical.

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Conflicts of interest

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