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A review on phytopharmacological properties of five jujube species: *Ziziphus sativa, Z. mauritiana, Z. mucronata, Z. lotus* and *Z. spina christi* (*Rhamnacées*)

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Abstract

The *genus Ziziphus comprises a very important* multi-purpose plant species that has been used in African traditional medicine for ages in the treatment of various devastating human and animal infections. The current paper is aimed at providing an overview of geographical distribution, botanical caracteristics, phytochemistry, uses and biological properties *of* five jujube species: *Ziziphus sativa, Z. mauritiana, Z. mucronata, Z. lotus and Z. spina Christi*, belonging to the *Rhamnaceae* family.

The information used in the current work was retrieved using various search engines, including *Pubmed*, *Science Direct*, *Google Scholar*, *Scielo*, *Sci Finder* and *Scopus*. The richness of these plants on phytoconstituents may well explain the reported biological activities.

Keywords: *diagnosis, pharmacy assistants, training needs.*

Introduction

The genus *Ziziphus* belongs to the *Rhamnaceae* family, Although there are around 170 species of *Ziziphus* around the world, there are only 58 species that are extensively used by local people and medicinal practitioners in arid and semi-arid regions to cure many diseases and as functional foods [1-4]. It is known by the ancient Greeks as the tree *zizyphon* and in the Arabic called "*Zizouf* or *Zefzouf*", with reference to its mythical name [5]. This genus includes trees, shrubs, climbers, and one herb [6]. The Rhamnaceae are regarded to be multipurpose plants and used as foods, folk medicines and environmental protector [7].

II. Geographical distribution and characteristics of the habitats

Because of their rusticity, jujube trees are often present in regions with an arid and sub-arid climate where the possibilities of fruit production are very limited [8,9]. Most of the jujubes known in Europe are fruits of mediocre size, but there are varieties with large fruits of excellent quality which would be interesting to propagate both in Asia and in Africa [10-14].

Ziziphus sativa Gaertner

The Asian jujube, Chinese jujube, or common jujube *(Syn. Z vulgaris Lam, Z. officinarum Medicus Mill,).*

The Common Jujube (*Zizyphus sativa*) is widespread in a vast part of temperate and subtropical Asia ranging from the Mediterranean in the west to Mongolia and subtropical China in the east. It exists in Turkestan, Japan, where it is subspontaneous. Its cultivation has spread to the South of the Caspian, to Turkestan and to Asia Minor, as well as to certain regions of Transcaucasia. According to the work of Vavilon [15], this species should be considered native to Afghanistan. It has been known in cultivation for more than 3,000 years. It was introduced in southern Europe, particularly in the Mediterranean region in the first centuries B.Christ. Its importance is even greater in China, where it is the most widespread of all cultivated fruit trees. Its fruits occupy the first place among those consumed by the Chinese people, where it plays a great role because of the food value of its fruits [1].

Fig 1: *Ziziphus sativa* Gaertner

B. Zizyphus mauritiana Lamk

The Afro-tropical jujube tree or tropical jujube. *(Syn. Z. jujuba Zizyphus orthacantha DC, Zizyphus vulgaris Lam., Z. insularis Smith.).*

It is very common throughout the Sahel and is still common near Sudanese villages where it can form real anthropozoogenic populations [16].

Its geographical area encompasses the arid and semi-arid zones of West Africa, East Africa from Nubia to Mozambique, Angola and overflows into Asia, Arabia, India. In tropical Africa, the species exists in a wild state in all savannah countries: Sahelian zones, all of West Africa, Chad Basin and Chari. In Asia: Arabia and the Indian Peninsula, Indochina, S China, Philippines, Indo-Malaysian archipelago, islands of Oceania, Australia. It is also naturalized in Madagascar and in the Mascarene Islands, in the West Indies [1,17].

Fig 2: Zizyphus mauritiana Lamk

C. Zizyphus mucronata Willd

The hyena jujube tree

It is found from the Senegal River to maritime Casamance. It is frequent around the temporary pools of the Sahel, along the Sudanese dry valleys and in the scree of the Bowes [16]. In Burkina Faso, it is mainly found in arid and semi-arid zones [18]. It is distributed throughout summer rainfall areas of sub-Saharan Africa, extending from South Africa northwards to Ethiopia and Arabia [19].

Fig 3: Zizyphus mucronata Willd

D. Ziziphus lotus Lamk

Berber jujube *(Syn. Ramnus lotus L, Z. sylvestris Miller, Z. parvifolia Delile.*

Its geographical area includes North Africa, Libya, the south and south-east of Egypt, Asia Minor, Cyprus, Greece, and Afghanistan. It is grown in southern Portugal,Spain and in Sicily. Its geographical area is extended to the Saharo-Scindian botanic domain = Sahara (Hoggar - llank), Mauritania (Adrar Soutouf, Adrar Tmar, Hodhi), Boucle du Niger (Bourem in Gao), Arabia, Pakistan [8,,9,20].

Fig 4 : Ziziphus lotus Lamk

E. - Ziziphus spina-christi WILLD

The Palestine jujube or Christ-thorn jujube (Syn. Ziziphus sphaerocarpa ; Z. africana Miller, Z. sphaerocarpa Tulasne, Z. nabeca Forsk.

Species native to the Orient but having adapted both to the arid climate of the desert in the oases and to the tropical climate in countries with a long dry season during which Z. spina-Christi partly loses its leaves. Its geographical area includes the Middle East, Asia Minor, Iran, Arabia, Nubia (Egyptian border of the Red Sea), Sahara (Aïr and Tibesti), the mouth of Niger, Chad (Baguirmi) and Ethiopia. It is cultivated in India, Pakistan, Syria, Egypt, Tunisia, in the Saharan oases

of Algeria and in Zanzibar [21,22].

Fig 5 : Ziziphus spina-christi WILLD

III. Botanical characteristics

Jujube trees are woody plants that sometimes take on a bushy appearance, with a very developed root system. The spreading branches often bear thorns, isolated or grouped in pairs [23]. The leaves are small or medium, more or less oval or elongated, sometimes acuminate, alternate, glabrous or hairy. The flowers are small. The fruit is drupaceous with a woody core, hard, rounded or elongated in shape, usually comprising two compartiments, only one of which contains a small kernel. The pulp is fleshy or dry, very rich in sugar in species with edible fruits, very variable in size and shape [24,25]. The botanical characteristics of the aerial parts (leaves, flowerx,fruits) of five jujube species are recapitulates in the Table I.

Table 1: Botanical characteristics of five species of the genus Ziziphus

Species Commun name	Characteristics	References
Z . spina christi ***Christ-thorn jujube or*** ***Palestine Christ-thorn jujube***	**Leaves**: oval to elliptical, trinerviate, glabrous on both sides, but very pale green below. finely serrated **Flowers**: yellowish-green **Fruits**: yellow to orange, globulous, size of a small olive, red or reddish brown when ripe, edible	*[22]*
Z mauritiana ***Afro-tropical jujube*** ***or tropical jujube***	**Leaves**: deciduous, varnished, alternate, tomentosous on their lower surface **Flowers**: small, yellow-green in color, with 5 petals **Fruits**: drupe in the shape of a small ovoid to spherical cherry, then red when ripe, rich in sugar.Edible	*[23,26]*
Ziziphus sativa ***Asian jujube, Chinese jujube or common jujube***	**Leaves** small, ovat, alternate, serrated or not, glabrous or hairy **Flowers**: small, yellowish **Fruits**: drupe similar to a large cherry or an olive, with a hard woody core, comprising a small almond. The kernel is covered with a semi-fleshy pulp, very quickly dry, rich in sugar. Edible.	*[24]*
Z. lotus ***Berber jujube***	**leaves**: oval-oblong, small, glabrous on both sides, deciduous, alternate, finely serrated **Flowers**: axillary, small; yellow, grow in clusters at the base **Fruits**: ovoid, oblong, size of a large pea, red when ripe, with a thin, yellowish-white, slightly glutinous, sweet pulp, covering a large kernel. Edible.	*[27,25]*
Zizyphus mucronata Willd ***Hyena jujube***	**Leaves**: alternate, broadly ovate with subcordal asymmetrical base and denticulate edges. **Inflorescence**: axillary cymes with numerous greenish flowers. **Fruits**: spherical drupes about 1cm in diameter, greenish then dark red-brown when ripe. The pulp is very bitter. inedible	*[16]*

Table II: Main biochemical components of five jujube species

Species	Biochemical components biochemical components	References
Z. sativa	ascorbic acid, proteins, sugars, lipids, starch, vitamin A, thiamin, riboflavin, calcium, phosphorus, saponins, flavonoïds, essential oil, mucilage.	*[28,29,26]*
Z. mucronata	Tanins, alcaloïds, saponosids.	*[30,31]*
Z. mauritiana	alcaloïds, sterols, triterpenoids, saponosids, tanins, flavonoïds, Amphibine, mauritin, rhamnose, galactose, iron, calcium, magnésium, zinc	*[31,32]*
Z. lotus	Sulfured proteins, sugars, vegetable oil, alcaloids, triterpenoids, flavonoids, polyphenols, saponins, tanins, pectin, sodium, phosphore, zinc, manganese, iron, calcium, potassium, magnesium, ascorbic acid and vitamin A	*[33,10,34,35,36,37]*
Z spina christi	Alkaloids, flavonoids, terpenoids, glycosids, saponins, tannins, triterpenes, lipids, proteins, free sugar and mucilage	*[38,39,17,40,41]*

IV. Biochemical composition of some species of the genus Ziziphus

Many phytochemical studies conducted on *Zizyphus* species show the presence of primary metabolites as well as interesting active secondary metabolites (Table II).

V. Fields of uses of jujube

The dry and thorny branches and the twigs of jujube tree are used to form defensive fences [42]. The leaves are widely used as supplementary fodder for camels and goats. It is the only spontaneous ligneous species found at the northern limits of the desert. In Africa, jujube wood is used for carving and carpentry [43]. The others parts of the jujube plants, especially the berries, have many uses as functional food and also as remedies for many diseases except *Zizyphus mucronata* fruits which is very toxic.

V.1. Food uses

In the last century, Jujube trees played an important role in the diet of certain populations, particularly those who inhabited ancient Libya, on the edge of the Gulf of Little Syrte (Gulf of Gabès), whose staple food, according to the ancient Greek authors, was constituted by the "lotos", the fruit of *Ziziphus lotus.* These populations, named "the Lotophages", made all kinds of dishes from it: bread, wine and a liqueur. Nowadays, jujube still being consumed by people in North Africa, the Middle East and China. In North Africa and south of the Sahara, the stands of jujube trees provide sometimes a significant food supplement to the populations, certain populations use a coarse flour extracted from the fruits of various jujube trees with dried fruits, by beating the exocarp, used in the confection of wafers eaten crumbled in milk or broth (it can be used pure or mixed with sorghum flour, with a pleasant sweet taste) [25]. Some Tuareg tribes, those of southern Algeria, Chad and Mali in particular, make with dry or dried jujubes, a kind of unleavened bread called "*Oufer*" found on the Gao market in particular, bread in the form of a thick pancake, pierced with a hole in the center or provided with a forked branch to allow it to be hung from the camel's saddle using a cord or strap. Jujubes from stands are sold on the markets of North Africa, Syria. and South of the Sahara [13]. Jujubes are still a harvested product providing a sometimes important food supplement to rural populations [10].

Z. sativa berries are widely consumed and very popular in China, where more than 400 varieties are known. Dried, they are used to make certain pectoral pastes and confectionery. By reducing them to powder, they can also be made into reserve food tablets or used form the preparation of syrups [25].

Z. mauritiana is sold dry in all Sudanese markets. By pounding them and separating the kernels, a flour is obtained which is used to make pastries. This flour can also be fermented and a pleasant drink is obtained. In Timbuktu, its fruits are used to prepare a liquor called "*jujubine*" obtained by distillation of this fermented drink. In Guadeloupe, a variety called *Surette* is cultivated, with a fruit the size of an olive, with a greenish-yellow or almost white pulp. It is acidic and very refreshing. Exquisite jams and jellies are prepared from it also. In Brazil they use the berries to make sorbets. In the central Sahara, the nomads of the desert (Moors and Tuareg) collect the fresh leaves with care and use them as a vegetable in couscous [26,31]. The wood is termite resistant, durable and easy to work with. It is used for making tool handles, kitchen utensils, ox yokes, beds and toys. It is also used in the construction of houses and attics in the form of posts or roof rafters. Thorny branches are used as fences. It is also good firewood and charcoal. The calorific value of the fruits reaches almost 4900 kcal/kg [26].

Z. lotus fruits are eaten as fresh food, preserved, dried, or used in confectionery and pastry, their juice can be used for the preparation of refreshing drinks [44]. In India, the ripe fruits are used for the preparation of dry products similar to those of the dry date. They are made into breads, they are also made into wine by crushing them and mixing them with water. This liqueur is very good to drink, but it can't be kept for more than ten days. Fresh fruits are sold in the markets. The inhabitants of northern Africa eat them as they used to; they sometimes even feed them to their cattle [10,45].

Z. spina christi has fleshy berries which are much preferred by the Syrians, Arabs and Abyssinians over all others. The fresh fruits are sold in all the markets of the Orient, Abyssinia and north Africa. These fruits are eaten fresh or used in the preparation of certain pectoral pastes or are used in confectionery [22].

V.2. Therapeutic uses

The species of the genus "*Zizyphus*" are widely used in traditional medicine for the treatment of various diseases, these therapeutic effects have been validated by numerous research works carried out on animal models by testing the properties of the different organs of these plants (Table III).

Table III: Biological activities of five jujube species

Species	Parts used	Biological activity	References
Z. mucronata	Leaves Seeds Roots bark	Antibacterial Antiinfectious Anti-enuretic Diuretic Aphrodisiac Anti-leprosy antisyphilitic vermifuge	*[18,16,46,47,48]*
Z. mauritiana	Leaves Seeds Roots bark	Immunostimulant Antidiabetic Astringent Antidiarrheal Antiinfectious Antiulcer Antivariolic Antifuruncular	*[49,50,51,26]*
Z lotus	Leaves Fruits Roots Twigs	Antidiabetic Sedative Analgesic AntiInflammatories Anti-Ulcer Antiinfectious Antibacterial Anxiolytic Antifungal Gastroprotective Antioxidant	*[52,17,53,54,55,56,28,44,57]*
Z. spina christi	Leaves Fruits Seeds	Antiinflammatory Healing Antiulcer Tonic Sedative Antioxidant Antidiabetic Antifungal	*[58,59,60,61,62,63,64,65]*
Z. sativa	Fruits	Antioxydant Antiseptic Diuretic	*[66,67]*

Conclusion

Jujube trees seem to have played an important role in the food and therapeutic field, which continue to be involved the flow of research works interested in this field. The charcterisation of the botanical and de phytochemical profile of *Zizphus* species are also very important to detect the differences between them. There is also a need to carry out the comprehensive safety profiles of these species, including heavy metal detection and toxicological characteristics. Further researches are needed to explore other compounds responsible for such activities and their mechanisms of action. Such activities validates the use of the plant species in traditional medicine. The data on the possible use of the plant species in the treatment of cancer, sexually transmitted infections, skin related and gynaecological complaints needs to be explored and validated both *in vitro* and *in vivo*.

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