Review Article

Ethnobotanical, ecological characterization and multiple interests of *Capparis spinosa* var. inermis Turra

Comment [S1]: the title you made does not reflect the content of the review

Abstract

The caper (*Capparis spinosa* var. Inermis Turra) is a bushy sub-shrub, 30 to 50 cm high. It is a small "sarmentose" shrub with unarmed twigs belonging to the Capparaceae family. It is a species of Saharo-Arabian and Mediterranean origin which is characterized by food, ecological, socio-economic and ornamental importance. It is also known for its medicinal and therapeutic virtues, which are very interesting given the pharmacological activities of the phytochemicals present in the different parts of the caper tree (roots, leaves, buds, fruits, bark and seeds).Its mode of propagation is by seed or by semi-woody, woody, semi-herbaceous and herbaceouscuttings.

Keywords : *Capparis spinosa* ; use ; ecology ; multiplication techniques; importance

I. Introduction

Tunisia by its particular geographical situation, contains a very varied range of climates supporting the development of the flora which contains more than 2160 vegetable species of which, one has more than 350, known by medicinal plants (Neffati et Sghaier, 2014).

This important biodiversity and richness of the flora is due to its location between the humid northern and dry southern regions (Brun, 2006). This immense heritage, whose seeds, fruits, leaves and even roots are used by man or his livestock. Among which, the forest and semi-forest species with socio-economic value capable of growing in the wild or cultivated state.

The aim is to promote the cultivation of multipurpose, fast-growing trees or shrubs and to develop management methods that can be easily adopted by the rural population and that ensure the sustainability of systems and biodiversity.

For this reason, great attention has been paid to the study of the Caper because of its use in various fields especially in food and medicine (Zhang et Feei Ma, 2018).The Caper is a plant of the family Capparidaceae, developed in the countries of the Mediterranean basin (Panico et al., 2005). It gathers to a shrub of length varies between 0.3 m and one metre (Meddour, 2011) which meets in rocky and mountainous ground (UNESCO, 1960).It is a perennial species, resistant to drought and well adapted´ to the Mediterranean ecosystem. Its cultivation is interesting having an economic importance (Rhimiet al., 2012) thanks to capers, the flagship product of this species.

The Mediterranean basin is among the regions of the world that have seen a serious development of the Caper (Benseghir boukhari, 2015 ; Harbouze et al., 2021). According to Barbera et Di Lorenzo, (1982), in 1960, Italy is the main place of production with 95% of the world production specifically in Sicily and the small islands (Salina and Pantelleria). While Spain was the main caper producing country until the end of the 70's, the caper growing areas are the coastal regions of the south-eastern provinces (Almeria, Murcia, Granada) and in the Balearic Islands (Luna Lorente et Massa Moreno, 1979). We also find that Morocco is the main producer of capers in the Mediterranean basin (Benseghir boukhari, 2015).Let us also point out that the Algerian Caper occupies spaces with marginal particularity or steep grounds such as the most productive are Annaba, Constantine, Biskra, Tebessa (Biri,1986 ; Ozenda,1983). In Tunisia, the caper is abundant in the hilly areas north and northwest of Tunis, they produced around 300 tons of capers in the 90s (Barbera,1991).It is within this framework that the study on the caper (*Cappris spinosa* var.*inermis*) is included.The present study proposes to list, through a bibliographic synthesis on the ethnobotanical characterization, the ecology and the utility of this plant in order to provide a reference document for the researchers who are involved in the research on this species.

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II. Taxonomy and botanical description of*Capparis spinosa* var. *inermis* Turra

Table 1. Taxonomy of*Capparis spinosa* var. *inermis* Turra

Reign	**Plantae**
Sub-kingdom	Viridae

Comment [S4]: why is the font different from the previous paragraph

Class	Equisetopsida C.Agardh, 1825
Clade	Spermatophyta
Subclass	Magnoliidae Novák ex Takht., 1967
Order	Brassicales Bromhead, 1838
Family	Capparaceae Juss., 1789
Genre	Capparis L., 1753
Species	*Capparis spinosa subsp. inermis A.Bolòs & O.Bolòs, 1961 (Synonymes: Capparis inermis Turra, 1780 (Capparis orientalis Veill., 1801*
French name	rock caper
Arabic name	Senior
English name	Caper

Comment [S5]: what does this number mean

II.2. Morphological and botanical characterization of the adult plant

The species is a bushy sub-shrub, 30 to 50 cm high. It is a small shrub "sarmentous" with inerminous branches of 1-2 m long (Abidi, 2014). *Capparis spinosa* var. *inermis,* it is distinct from the var. spinosa by the shape of the branches and leaves.

II.2.1 Aerial part of the plant

The caper plant is characterized by woody stems at the base and very branched with the appearance of a developed tuft, bearing stems at the neck (Fig.1). These stems are woody and short, from which herbaceous branches emerge every year and gradually become woody (Abidi, 2014).The leaves of this species are distinctly oval, with a rounded tip and a distinctly cordate base, sometimes succulent, due to the absence of spines. They are often deciduous at the juvenile stage (Rouissat, 2017). They are alternate, whole, simple, rounded to oval. They are light green in color, well developed and clearly petiolated with a network of veins protruding from the paler lower side (Kenny, 1997). These leaves are characterized by relatively thick cuticles capable of restricting the transpiration of the plant in dry and difficult conditions. The leaves of the caper have at the base two stipules transformed into fine bristles

which become deciduous giving the appearance of plants without spines in the botanical variety *C. spinosa* var. rupestris or inermis (Pottier-Alpetite, 1979) (Fig.1).

Figure 1. *(a) Adult caper shrub in vegetative rest; (b) new leaves(c) adult caper shrub in vegetative stage (photos ofRefka Zouaoui, 2020)*

Capers are closed flower buds harvested before flowering (Fig.2). They have a very high moisture content (83%) and must have certain dimensions to be marketed (Özcan, 2005). Phytochemical detections of capers showed the presence of flavonoids and tannins. Total phenols were estimated to be in the order of 51.1mg GAE/g extractive. Capers are harvested at specific dates and prepared in different ways (vinegar, salt) depending on the country (Bektas et al., 2012).

Concerning the flowers, they are of purplish blue color and are clearly bilabiated. The posterior lip being very developed that the inferior lip (Pottier-Alpetite, 1979). Caper flowers are exceptionally beautiful but ephemeral (Fig.2). They bloom at the end of the afternoon and wither during the following morning. The caper is an allogamous plant with entomophilic pollination provided mainly by moths (Crété, 1965).

They are solitary in the axils of the leaves (Inocencio et al., 2002). The fruit of inerme caper (capron) is an oblong, ovoid, ellipsoid or globular berry, green in color with well-defined longitudinal nerves, along which a dehiscence occurs later. A fruit, which is dark purplish in color and soft under the fingers, usually contains ripe seeds (Bhoyar et al., 2010 ; Khaninejad et al., 2012) (Fig.2).

Several active compounds in caprons such as total phenols (17.56 mgGAE/ g extract), flavonoids, glucosinolates, alkaloids, tannins...) have been identified (Satyanarayana *et al*,

Comment [S6]: This section is merged into the last paragraph of this sub-chapter, which deals with secondary metabolites of the plant Capparis spinosa

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2008 ; Arslan et al., 2010 ; Bektas et al., 2012). The caper seeds are multiple. They are generally of brown color at maturity (Fig.2), immersed in a reddish or yellow pulp.

The shape, color and size of the seed have limited taxonomic value (Rivera et al., 2002). Caper seeds are exalbuminous and have 27.3 to 37.6% volatile oils. The embryo is curved, voluminous and occupies a large proportion of the seeds (Crété, 1965).

***Figure 2**. (a)Flower buds or caper ; (b) Caper flower; (c)Mature caper shrub rich in caper fruit « mature capron » ;(d) Caper seeds ; (e) Caprons in dehiscence (Photos ofRefka Zouaoui, 2020)*

II.2.2. Root system

The underground part of the caper is characterized by a very deep taproot system (Kenny, 1997). This characteristic confers to it a strong tolerance to the drought from where its

adaptation to the dry regions. It has the particularity to develop on the poorest soils, the driest and on grounds with strong slopes (Abidi, 2014).

II.3. Life cycle of the species (Phenology)

The vegetative budding of the caper takes place in the spring at the first sun rays. In arid areas, the leaves are evergreen. The leaves are deciduous at the end of the summer (Nègre, 1961). The flowers of the caper bloom from June to September (Inocencio et al., 2002). The collection of fruits takes place from July to September and from May in the warmest regions (APAT, 2003). The harvest of mature caper seeds is done at the end of the summer on ripe fruits (Khaninejad et al., 2012 ; Bhoyar et al., 2010).

III. Caper propagation techniques

The multiplication of the caper can be done by several methods :

III.1. Sexual multiplication by sowing seeds

Seeds from crushed ripe fruit (late summer) are rinsed with tap water, dried in the shade and stored at room temperature in polyethylene bags until use (Khaninejad et al., 2012; Bhoyar et al., 2010). For germination, caper seeds can be used immediately after harvest. On the other hand, with maturity, their envelopes become hard and require pretreatments before the setting in germination (Pottier-Alpetite, 1979). In the southern European countries where the caper is cultivated, the sowing in nursery at the end of winter (February) and the transplanting of the plants obtained at the end of spring is a common technique for the propagation by seed of this species.According to Barbera and Di Lorenzo (1984), 5% of the seeds sown in February can germinate in May. The plants obtained are transplanted in summer when they reach the 3-4 leaf stage and measure between 10-20 cm.

III.2.Vegetative propagation by cuttings

Caper can be propagated by semi-woody, woody, semi-herbaceous and herbaceous cuttings.

Concerning the semi-linear cuttings, the cuttings are taken from the apical part of the branch bearing an apical bud in addition to the axillary buds. These cuttings are taken from adult shrubs or from the stump of two year old plants (Laribi et al., 2013).

In the caper, this type of cutting is done from July to October with a percentage of rooting which varies between 50 and 70 % for the caper inerme (Marouani, 2013). Whereas woody cuttings are taken from the Augusted branches of mature shrubs. It is the most practiced

method to obtain plants of several trees and shrubs. The taking of cuttings is done in periods of rest of the mother plant in October-November after the end of the harvest and the fall of the leaves. The caper cuttings, 20 to 30 centimeters long, are taken from the basal part. They are then put in stratification during all the winter period either in the sand or in a cold room at a temperature of 3 to 4°C (Barbera, 1991). These cuttings will form roots after 4 to 5 months and planting can take place in March-April. The rooting percentage of this type of cuttings varies between 50 to 70 % (Marouani, 2013).

Herbaceous cuttings, on the other hand, involve cuttings taken from green twigs. The success rate of herbaceous cuttings varies from one nursery to another. It can reach 90% from the cuttings resulting from the vitro-plants in the caper inerme taken in May (Ghorbel et al., 2001).

III.3. Caper cultivation and caper production

Caper cultivation can be combined with other fruit crops such as olive, vine, almond and citrus (Lakrimi, 1997 ; Marouani, 2013).

III.3.1. Planting substrates for cuttings

The choice of the substrate for the plantation of the cuttings is an important criterion for the success of the cutting. This is due to the physical properties of the growing medium which can affect by drainage and aeration (Wilson et Stoffella, 2006). The absorption of water by the cuttings is indirectly proportional to the water content of the medium which is determined by the properties of water retention and aeration of the medium (Grange et Loach, 1983). Planting the cuttings in a substrate composed of a mixture of sand and perlite promotes the greatest number of roots (Taghvaei et al., 2012). Perlite-based substrates have better aeration and higher water retention capacity (Ofori et al., 1996). Indeed, the use of this substrate allows plants to optimize water and oxygen. It can affect the growth and development of roots and shoots in a direct or indirect way (Abidi, 2014).

III.3.2. Transplanting cuttings

The plantation of the cuttings can be done from February but preferably in April. Considering the fragility of the root system of the caper, it is necessary to work well the ground before the plantation. The holes of plantation must be from 30 to 50 cm of depth (Güleryüz et al., 2009). According to Lakrimi (1997), it is also recommended that the planting holes be placed 15 to 20 cm lower than the soil level to provide better protection for the young plants (Abidi, 2014).

III.3.3. Planting density

The planting density varies from 1600 to 2500 plants per hectare depending on the region and the vigour of the variety used (Ofori et al., 1996). According to Lakrimi (1997), the density of plantation can vary from 1200 (3×2.5m) to a maximum of 2500 (2×2m) plants per hectare depending on different factors (the nature of the soil, the region and the vigour of the variety used).

III.3.4. Caper production

The production of capers varies according to countries. In 2005, the main caper exporting countries were: Morocco, Spain and France (Razouki, 2013). Other recent studies have noted that Morocco is the first caper producing and exporting country in the world with an annual production of 20,000 tons and holds 3/2 of world exports. Turkey is found to join the other main producing countries.

On the other hand, the main importing countries of capers are the countries of the European Union (Italy, Spain, ...), the countries of Latin America (Brazil, Venzuela, ..., as well as the Asian markets. Exports are made up of several types, namely the semi-preserved, packed in barrels and the type preserved in metal boxes or glass bottles (AVFA, 2020). In particular, the production of capers in Tunisia remains very limited compared to the production of the other Mediterranean countries. In 1997, the export of a quantity of 4717 kg of capers, brought 11.345 DT. In 2001, the national production was 151 tons of capers for a value of 398 000 USD. The production has clearly regressed since it was 358 tons in 1982. A part of capers is exported by the industrialists in food canning (Chakib et Lehoux, 2012).In fact, it has fluctuated between 160T and 200T per year coming essentially from the wild groundwater (Razouki, 2013).

Comment [S8]: What do these dots mean?

According to the size of the flower buds harvested, six categories of capers are distinguished in the trade : not the same (diameter less than 7mm) ; surfines (7 to 8 mm diameter) ; nasturtiums (8 to 9 mm diameter) ; hoods (diameter from 9 to 11 mm) ; fine (diameter from 11 to 12 mm) and semi-fine (diameter over 12 mm) (AVFA, 2020).

IV. Geographical distribution and ecological requirements of *Capparis spinosa* var.*inermis*

IV.1.Geographical distribution

The species Capparis spinosa var. inermis is of Saharan-Arabic and Mediterranean origin. It is observed in small colonies in the central and northern Sahara (Lakrimi, 1997 ; Jiang et al., 2007). In Tunisia, the smooth caper C. spinosa var. inermis Turra is present in the national

park of Zembra (El Hamrouni, 2001). In the north of Tunisia, the island of Tabarka, island of Pilau Rafraf, island of Zembra, DJ Ichkeul, Oued Sedjenane, Ras Zbiba, El Haouaria, Korbous, Sidi Bou Saïd, Ariana. In the center of Tunisia: Oued Marguellil, Kef, Kessra, Sbikha, Sidi Bouzid. In the south of Tunisia: Kébili, Matmata, Chenini of Tataouine (Pottier-Alpetite, 1979 ; Chaabane, 1993 ; Ghorbel et al., 2001).The caper slicks have been severely degraded over the last 20 years. They are estimated at 226 ha distributed in different regions: Beja, Zaghouan, Kef and Kairouan (APIA, 2013).

IV.2. Ecological requirement

Caper is a xerophytic plant that tolerates drought and extreme climatic conditions in arid and semi-arid areas (Gan et al., 2013 ; Ghayour et al., 2013). It tolerates extreme temperatures ranging from -4 to over 40°C (Lakrimi, 1997). In the Mediterranean region, rainfall favorable to the caper varies from 200 to 400 mm. In Spain (island of Majorca), in Morocco and in Turkey rainfalls less than 400 mm characterize the regions of caper production. In Italy (Sicily) the most productive caper plantations receive less than 450 mm. Moreover, this species tolerates perfectly the sea winds loaded with salts, which means that it must also show a certain tolerance to the salinity (Lakrimi, 1997). It normally grows on hills exposed to winds for several months of the year (Benseghir Boukhari, 2015). Concerning the edaphic requirement of the species, it is a calcareous shrub which requires stony calcareous soils slightly clayey and well drained. It adapts perfectly to various types of calcareous soils, even the most rocky and the most ungrateful (Marouani, 1996 ; Ghayour et al., 2013). It develops on cliffs, gorges, slopes, rocky soils, wadi banks and high points of talwegs. This species is also found on the old walls (Lakrimi, 1997).

V. Multiple uses and interests of *Capparis spinosa* var. *inermis* Turra

The smooth caper has multiple interests. It is also used as food, fodder, melliferous and ornamental plant. It has important medicinal qualities used in traditional medicine (Güleryüz et al., 2009 ; Marouani, 2013).

The caper has an undeniable economic importance. It is a species of socio-economic interest. Indeed, the preliminary ecological assessment of the work carried out shows that the caper could also have an implication in the fields of the rural economy (Pottier-Alpetite, 1979 ; Chakib et Lehoux, 2012). It should also be noted that the cultivation of this shrub dates back to antiquity; its flower buds, young shoots and tender young fruits are used in human food (Güleryüz et al., 2009). The caper is a condiment commonly used in the kitchen of most

Mediterranean countries. In Tunisia, the caper is an essential condiment in recipes (soups, salads, brik, pizza ...). In Turkey, the local people of Mersin ('Yoruk') use capers for salad, pickle and jam (Everest et Ozturk, 2005). Italy is famous for the use of capers on different dishes (Marouani, 2013).In addition, thanks to their habit (upright or climbing) and their inflorescences, this species is considered as ornamental (Guiseppe, 1991). The caper with its beautiful flowers and flower buds has been used to decorate postage stamps in Tunisia, Algeria and Morocco.

Let us never forget the use of this species in medicine where the leaves and fruits are used for the treatment of various human diseases, including gastrointestinal problems, anemia, liver disorders, rheumatism. In addition, they are antispasmodic analgesic; anthelmintic, anti hemorrhoidal, laxative, depurative(Sher et Alyemen, 2010). In traditional medicine, the Greeks use caper root and young shoot teas against rheumatism. The caper is also used for the treatment against certain cancers (Benkhnigue et al., 2011). It is used to alleviate symptoms and treat diseases such as toothache, fever, menstruation (Sher et Alyemen, 2010).

Comment [S9]: Make a specific discussion about the benefits of this plant

VI.Conclusions

Caper cultivation plays a major socio-economic role in several regions of Tunisia. It offers the advantage of being little demanding in water and investment and of being tolerant to the conditions of aridity. Moreover, the production has extraordinary export outlets.

VII.References

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