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Profiling and importance of underutilized neglected species of hyper arid climate of Saudi Arabia (*Retama raetam - Retem*): A review

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Abstract: Kingdom of Saudi Arabia (KSA) is the largest country in Arab Peninsula. However, most of its land is classified as arid or hyper arid with rare vegetation cover. *Retama raetam* (*Retem*) is found in the drier parts along the Northern Western region of KSA. *Retem* is well known as drought tolerant species with wide range of traditional medicinal uses. In order to validate the traditional uses, recently many studies were conducted regarding phytochemical analysis and pharmacological activities. However, very few information about the importance of this species and its profile are available. The aim of this review is to highlight the updated information on the profile and values of this species. *R. Raetam* is a true arid land plant species with very deep root system, assimilating green branches and small leaves that are drop very quickly to conserve water loss. In addition to that phytochemical profiling of the species revealed many compounds of high pharmacological values such as flavonoids, alkaloids and pinitols. As the result different parts of this plant exhibited medicinal properties such as antioxidant, antifungal, antibacterial, antiviral, antihypertensive, diuretic, antiseptic, hypoglycaemic, anti-inflammatory and body weight lowering. This review reflects the importance of including this species in the priority list in KSA as potential multi-uses for degraded land rehabilitation.

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1. Introduction

Retama raetam, called White Broom or While Weeping Broom (common name) *Retem* (local name) is a leguminous nitrogen fixing plant of family *Fabaceae*. It is a desert shrub adapted to withstand recurrent drought spells and harsh environments. It is native to many countries including Western Sahara to Sudan, and Sicily and extending to the Sinai Peninsula, Palestine and Saudi Arabia (Al-Tubuly, et al., 2011). However, the plant now is widely naturalized in many countries (POWO, 2020). It is characterized by deep root system which penetrate deeply into the earth and slim branches that are adapted to decrease the surface area exposed to the desert dry air. Nevertheless, these branches are green which are responsible for most of photosynthesis to compensate for the small leaves that are drop immediately to conserve water loss through transpiration (Awen, et al., 2011).

Retem is very long time ago is used as a source of traditional medicine in many countries. Decoctions from the aerial parts are used by local peoples to treat hypertension, diabetes and rheumatism, as well as anti-inflammatory (Tahraoui, et al., 2007).

However, recently many studies were conducted about the pharmacological activities of the plant. The results confirmed that different parts of this plant possess antioxidant, antifungal, antibacterial, antiviral, antihypertensive, diuretic and hypoglycaemic properties, as well as hepatoprotection, nephroprotection and cytotoxic effects (Saada, et al., 2018; Hammouche-Mokrane, et al., 2017; Algandaby, et al., 2015; Algandaby, et al., 2010; Koriem, et al., 2009; Hayet, et al., 2008; Eddouks, et al., 2008; Hayet, et al., 2007). The chemical assay of active ingredients showed the plant is rich in flavonoids (Kassem, et al., 2006), alkaloids (Hammouche-Mokrane, et al., 2017) and pinitol (Gonzalez-Mauraza, et al., 2016).

Total area of the Kingdom of Saudi Arabia (KSA) is approximately two million $Km^{2,}$ representing 70% of the Arab Peninsula (Saudi Geological Survey, 2017). Despite, this large area the

forest cover and other wooded vegetation occupy a very small area compared to the total land surface area of the country about 1.3%) (FAO, 2015). Large part of the country is lying within hyper arid or arid zones with little or no rainfall (Nejatian, 2013). In the dry land forests, *Retem* plant is found in the vegetation communities of the north western part of the country extending form Al-Jouf to Tabuk.

Although the conservation status of this species is classified as not threatened in the IUCN red list (Roskov, et al., 2020), However, still the plant in Saudi Arabia is hardly under impact of many deteriorating factors (Al-Mutairi, et al., 2016). These include camping (This especially during winter camping when there is increased need by the peoples for firewood for warming), firewood collection and sand creep.

2. Species profile

Nomenclature

Scientific name: *Retama Raetam* (Forssk.) Webb & Berthel.

Common names: White Broom or While Weeping Broom.

Local names: *Retem* in Arabic.

Synonyms: It has three Synonyms: *Genista raetam* Forssk., *Lygos raetam* (Forssk.) Heywood and *Spartium raetam* (Forssk.) Spach.

Intraspecific taxon:

According to IUCN, red list species profile (Roskov, et al., 2020), there is two main intraspecific taxon: *Retama raetam subsp. rataem* and *Retama raetam subsp. Gussonei* (Webb) Greuter.

While according to the Kew botanical Garden (POWO, 2020), there is the three intraspecific taxon: *Retama raetam subsp. Bovei* (Spach) Talavera & P.E. Gibbs, *Retama raetam subsp. rataem* and *Retama raetam subsp. Gussonei* (Webb) Greuter.

Classification

Kingdom:	Plantae - Plants
Subkingdom:	Vascular plants
Super division:	Seed Plants
	Flowering plants
Division:	Dicotyledons
Class:	Rosidae
Subclass:	Fabales
Order:	Fabaceae / Leguminosae
Family:	*Retama Raf*
Genus:	*Retama raetam* (Forssk.) Webb & Berthel
Species:	

History

R*etem* species was first described as *Genista raetam* by Peter Forsskål in 1775. The epithet was derived from the Arabic name that was transcribed by Forsskal as "*rætæm beham*". In the year 1842 Philip Barker-Webb and Sabin Berthelotthe were transferred the species to *Retama*. The species that occurs in the Canary Islands is now considered to be *Retama rhodorhizoides*, rather than *R. raetam*, although the latter name has been used for Canary Island plants.

Conservation Status

Not threatened (IUCN red list, Roskov, et al., 2020).

Description

According to a guide to medicinal plants in North Africa written by IUCN (Benhouhou, 2005), *Retem* is described as leguminous green plant, slender and weeping multi-stemmed shrubs belongs to the family *Fabaceae*. The plant has green stems which responsible for much of the photosynthesis, especially during the dry season. The shrub normally about 3 meter tall, but may reach up to 6 meters. It branches from the base, while the young stems are covered with hairs become hairless with age. Leaves are very small, narrow and alternate and drop very quickly. Inflorescence are dense racemes with white 8 -10 cm long flowers in cluster of 3 – 15. The pods are pubescent hairless (10 – 15 mm in diameter) and contains one or two kidney shaped yellow, green, brown or black seeds. Flowering during February, March, April up to May.

Distribution

The natural range of *R. raetam* is extending in arid ecosystems around the Mediterranean basin from Arab Maghreb countries (Algeria, Morocco Tunisia, Libya and Mauritania) and up to Sicilia. In Africa it is found in Western Sahara, Egypt, and Sudan. It is also, occurs in Saudi Arabia, Sinai Peninsula and Palestine (Al Tubuly, et al., 2011; POWO, 2020) (Fig 1). In Saudi Arabia it is found North Western part of the country from Al-Jouf to Tabuk (Fig. 2). Now days it is widely naturalized in many places, including Greece, Queensland, South Australia and Western Australia (POWO, 2020).

Branches with followers, fruits and seeds of *Retem* plant from Tabuk region, Saud Arabia (photo, 2019)

Figure 1. Countries with green colour represent the natural distribution of *Retama raetam* species

The map is from Kew Garden, Plants of the World on Line with slight modification (POWO, 2020).

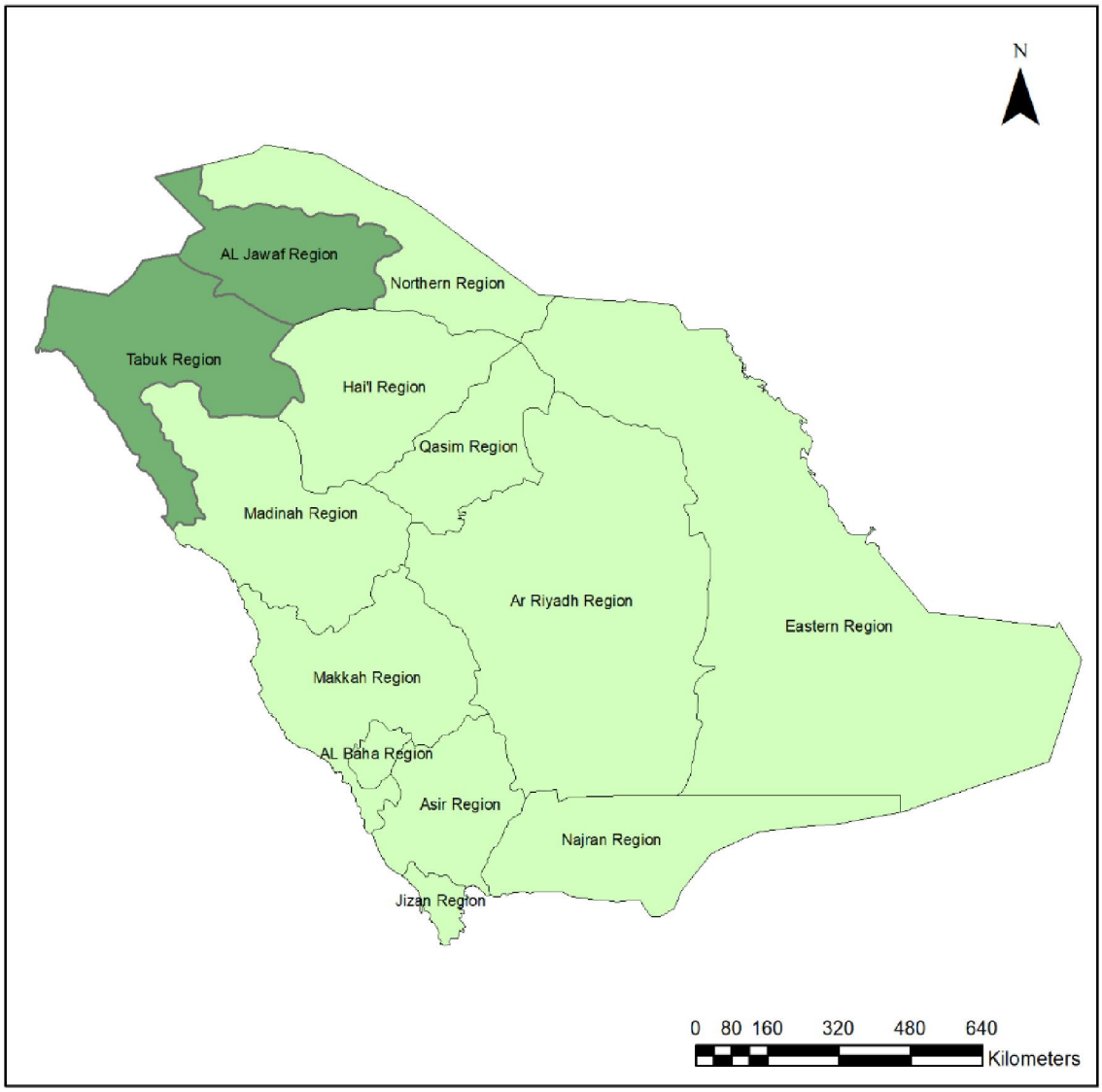

Figure 2. Areas with green colour represent a natural range of *Retama raetam* distribution in Kingdom of Saudi Arabia

Ecological requirements

Retama raetem grows well under sandy soils and low annual rainfall (in the range of 100 mm per annum) (Mittler *et al.,* 2001). The shrub is very tolerant to extreme dry drought conditions (Farida, et al., 2009). The species is of high ecological interest for sand dune stabilisation, soil fixation, and revegetation of degraded lands in semiarid ecosystems (Caravca, et al., 2003). It grows well on sand dunes slopes or dunes base (Benhoulou, 2005).

Uses

As rehabilitation species

R. raetam serve as one of most important desertification and degraded land rehabilitation plant. The plant contains very small leaves that are readily drop after formation to conserve water loss through transpiration (Leon-Gonzalez, et at., 2018). While the branches are green and capable to photosynthesize to compensate for assimilation (Benhoulou, 2005). This shrubby leguminous plant is capable of fixing rhizobium nodulating bacteria (Farida, et al., 2009). It can be used for the phyto-stabilization of degraded soils (Caravaca *et al.,* 2003), as well as remediation of soils contaminated by heavy metals and mining sites soils (El Idrissi, et al., 2019).

Retama raetam stand in Tabuk Region, Saudi Arabia (photo, 2019).

Forage value

There is a lot of debated about the value of the forage produced from this species due to the toxicity caused by many phytochemical compounds. In another turn most of the year the plant remains leaveless due to the continuous shedding of newly formed leaves. However, Barakat, et al., (2013) contradicted these debates by reporting potential forage crop with good nutritional quality for browsing animals. Furthermore the plant increases the productivity of forage system of herbaceous plants under its understory (Rivest, et al., 2011). This increase in forage productivity under canopy is attributed to the improvement in the micro-environmental conditions and the nutritional status through litter fall caused by the presence of *Retem* (Valles, et al., 2011).

Traditional medicine

R. raetam is traditionally well known for its famous folk medicinal values in many countries across its natural range (Leon-Gonzalez, et al., 2018). Local people use leaves powder for healing or as wounds antiseptic or for skin irritation treatment (Awen, et al., 2011). It is also, traditionally used for the treatment of renal diseases (Gonzalez-Tejero, et al., 2008). It can be applied for the cure of hypertension due to its significant diuretic activity (Kassem, et al., 2000). Moreover, it is applied against several diseases such as jaundice, joint pains, sore throat, inflammation, fever and microbial infections (edziri, et al., 2012; Djeddi, et al., 2013). In Tunisia, it is used as remedy against snake bites (Hamroumi, 2001). The Bedouins in some areas use *Retem* as a folk remedy for treatment of backache, arthralgia, infertility and for inducing abortions by means of oxytocic effect on the uterus (Bailey and Dannin, 1981). In Saudi Arabia and Morocco it is applied for the treatment of diabetes and hypertension (Nur -e-Alam, et al., 2019), while in Tunisia it is used for traditional treatment of some renal diseases (Edziri, et al., 2010).

Phytochemical properties

Because of its wide application in traditional medicine, recently many phytochemical studies were conducted in regards to the ingredients suitable for different medicinal purposes. It was reported that extracts from different parts of the plants contains high concentration of phenolic compounds with large numbers of phenolic acids and flavonoids (Marriem, et al., 2014), many different alkaloids and flavonoids (Hammouche-Mokrane, et al., 2017), pinitols (Gonzalez-Mauraza, et al., 2016), as well as antioxidant enzymes (Khan, et al., 2016). The flowers contain essential oil with antiseptic and antimicrobial activities (Awen, el al., 2011). In addition to that new flavonoids isolated in plants grown in Saudi Arabia

(Nur -e- Alam, et al., 2019) and from the aerial parts of the plant (Xu, et al., 2015). Whereas, Djeddi, et al., (2013), isolated secondary metabolites with analgesic properties from the aerial parts. Furthermore, Awen, et al., (2011) and Edziri, et al., (2010) analysed the chemical composition of the essential oil extracted from the flowers and its effects as antimicrobial agent.

Pharmacological activities

In order to validate the information generated by local population about the pharmacological uses of this species many studies were conducted. Extracts from the aerial parts of the plant exhibit high antioxidant activity (Saada, et al., 2018); antibacterial activity (Hammouche-Mokrane, et al., 2017); anti-inflammatory (Gonzalez-Mauraza, et al., 2016); effects in nervous system (Al-Tubuly, et al., 2011) and hypoglycaemic activity (Maghrani, et al., 2005; Hayet, et al., 2008). While essential oil from the flowers revealed antibacterial and antifungal activities (Edziri, et al., 2010) and antiseptic and antimicrobial properties (Awen, et al., 2011). Where some studies showed flavonoids α-glucosidase inhibitory activity (Ghani, et al., 2019); low nephrotoxic subacute toxicity potential (Algandaby, 2015) and antidiabetic activity (Algandaby, et al., 2010).

Table 1. Phytochemical compounds, pharmacological activities and values of *Retama raetam*

Photochemical, activities and values	
New falavonoids isolated from Retem grown in KSA	Nur -e- Alam, et al., 2019
Flavonoids α-glucosidase inhibitory activity	Ghani, et al., 2019
Fatty acids, carotenoids, proline and phenolic compounds antioxidant and their biological activities	Saada, et al., 2018
Review of plant traditional values, phytochemistry and pharmacological properties	Leon-Gonzalez, et al., 2018
Isolation of alkaloids and flavonoids and their antibacterial activities	Hammouche-Mokrane, et al., 2017
Pinitol, anti-inflammatory and antidiabetic properties from the aerial parts of the plant	Gonzalez-Mouraza, et al., 2016
Effects of acute and subacute toxicity on body weight, haematological values, blood chemistry, organ weight, and histopathological testing of liver and kidney	Algandaby MM, 2015
Antioxidant enzymes and secondary metabolites across different elevations	Khan. et al., 2016
Two new flavonoids isolated from aerial parts	Xu, et al., 2015
Assessment of total phenols, flavonoida and condensed tannins and testing of antioxidant and antimicrobial activities	Mariem, et al., 2014
Evaluation of Retem as forage crop for browsing animals	Barakat, et al., 2013
Isolation and structure of secondary metabolites of aerial parts and their anglesic properties, plus root extracts antioxidant	Djeddi, et al., 2013
Two flavonoids extracted from flowers tested for antibacterial, antifungal and cytotoxic activities	Edziri, et al., 2012
Aerial parts methanol extraction and its effects in nervous system	Al-Tubuly, et al., 2011
Antiseptic properties, chemical composition and antimicrobial activities of essential oil extracted from flowers	Awen, et al., 2011
Flowers essential oil composition and its antibacterial and antifungal activities	Ediziri, et al., 2010
Isolation and molecular characterization of rhizobium bacterial nodulating strains from roots of Retem	Farida, et al., 2009
Hypoglycaemic activities of aerial parts extracts	Maghrani, et al., 2005
Description of *Retama* plant	Benhouhou S., 2005
Antioxidant and cytotoxic activities of leaves extract	Conforti, et al., 2004
Isolation of soluble galactomannans from *Retem* seeds	Ishurd, et al., 2004
Flavonoinds isolation from aerial parts	Kassem, et al., 2000

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