Conservation Strategy for protecting *Crataegus x sinaica* against climate change and anthropologic activities in South Sinai Mountains, Egypt

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**ABSTRACT**

The genus name *Crataegus*, is derivative from a Greek word *kratos* meaning hardness of wood. *Crataegus* relates to family *Rosaceae*; it contains about 280 species of deciduous spiny shrubs and small trees where most of these species are grown as ornamentals and hedging plants, they are broadly distributed in Northern temperate zones of Asia, Europe and America. In Egypt, it is confined to mountainous South Sinai: it grows on the high elevated wadis in Saint Catherine area. Many *Crataegus* species have been traditional used in folk medicine since ancient time for the cure of heart problems such as hypertension, angina, arrhythmia, and congestive heart failure. Researches of *Crataegus* species usually concentrate on the identification and quantification of flavonoids and anthocyanin, which have been shown to have pharmacological activity. But there is a continuous reduction in habitat quality for this species through time. This reduction observed in *Crataegus sinaica* is likely caused by climate changes in the past few decades and human activities (over cutting for fuel and food, unmanaged collection for scientific researches, uncontrolled tourism and establish of bedouin settlements). We aim to highlights these challenge threatening *Crataegus* population and suggest conservation plans to protect this species from extinction and finally make further studies about this important threatened species.

**Keywords**: *Crataegus sinaica*, *Rosaceae*, flavonoids, Cardiovascular, Conservation.

**INTRODUCTION**

The genus name *Crataegus*, is derivative from a Greek word *kratos* meaning hardness of wood (Verma et al., 2007). *Crataegus* relates to family *Rosaceae*; it contains about 280 species of deciduous spiny shrubs and small trees where most of these species are grown as ornamentals (Hyam and Pankhurst, 1995). Hawthorn is public name of all plant species in the genus *Crataegus*, is a thorny shrub or small tree is called in common as Za’a’roor Al-Awdya or Za’a’roor grows wildly on the mountains of Saint Catherine Protectorate, South Sinai, Egypt. Flavonoids and procyanidins are considered as the most important components and responsible for the pharmacological activity of Hawthorn. The fruits contain reasonably low levels of flavonoids and consist of oligomeric and polymeric procyanidins.

Many *Crataegus* species have been used in traditional folk medicine since long ancient time for the cure of heart diseases as deficiency of the coronary supply and arrhythmias (Fugh-Berman, 2000) due to their evident improvement of heart functions in declining cardiac performance (Refaat et al., 2010; Ahmed et al., 2001), besides their hepatoprotective (Refaat et al., 2010), antimicrobial activity (Tadic et al., 2008), anti-HIV (Shahat et al., 1998), anticomplementary (Shahat et al., 1996), cytotoxic activity (Min et al., 2000; Hamahmeen and Jamal, 2013), hypotensive, antioxidant (Amel et al., 2014), antispasmodic, hypotensive (Ercisli et al., 2015; Tahiriović and Bašić 2014; Kumar et al., 2012). These plants are usually contain high amount of flavonoids, proanthocyanidins and catechins which are the main components responsible their biological activities.

In the last 20 years, over 60% of new drugs for the cure of cancer and 75% of new drugs used to cure infectious diseases were of natural origin (Newman and Cragg, 2007). More than 25% of pharmaceuticals are derived from plants and the potential of this high resource is massive, (Lambert et al., 1997). These products include those which have been made from *Crataegus* species (hawthorn); available products include tinctures, tablets, teas, and aqueous extracts of *Crataegus* leaves, flowers, and fruits. Hawthorn products are currently marketed as an alternative treatment for hyper tension, angina, arrhythmia, and the early stages of congestive heart failure.

Due to many threats affecting the existence of *Crataegus sinaica* in its environments including overgrazing, over-cutting and climate change, this review article we aimed to make efficient natural control, wise management for present populations and figure out a conservation strategy for protecting *Crataegus x sinaica* as a threatened plant species growing in Saint Catherine Protectorate in South Sinai.

**Distribution**

*Crataegus* is documented in northern temperate regions, including North America, Europe, Asia Minor, China, Japan, the Old World and the Himalayas. This plant species represents the concept of endless variation, with numerous variants that in the late nineteenth century led to the naming of upwards of 1,000 species of hawthorn. *Crataegus sinaica* is restricted to central and eastern parts of the Mediterranean region; on rocky mountain slopes, in scrub and woodlands; 100-1800 m a.s.l.

*Crataegus* is well distributed in the flora of Syria, Palestine and Egypt (Post, 1896). In Egypt, *Crataegus sinaica* is distributed in the Catherine Mountains of southern Sinai (Fig. 1a). It is abundant mainly in the timber line zone and occurring at different elevations on Gebel Catherine, Wadi El-Raha, Gebel El-Ahmer, Gebel Musa, Wadi El-Rutig, and Gebel Um Alawi

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(Fig.1b) (Moustafa and Klopatek, 1994).

**Figure (1a):** *Crataegus sinaica* is restricted to mountainous Saint Catherine, South Sinai.

**Morphology**

Hawthorn plant is an erect, branched shrub or small tree (Fig. 2a) which can grow to 7m high and 7m wide. The branches are thick and armed with thorns more than 25 mm long. The leaves are lobed and by width 1 to 6 cm. Flowers are in different colors white, cream or pink and grow in flat-topped clusters shape which presents at the ends of branches. They bear orange to red fruits (Täckholm, 1974). The fruit holds two or three seeds. Seeds start to germinate in autumn. Primary growth starting slowly and plants do not flower until the second or third year come. Flowering occurs at the end of spring to the start of summer, and leaves are sheltered in autumn. Plants are living a long time probably for more than 70 years. Hawthorn plant reproduces by seeds and suckers. A mature tree produces more than 2000 fruits, each one with 1 to 3 seeds. Seeds remain dormant for two years or more than this (Danin *et al*., 1985).

**Chemistry and natural products**

The chemistry of *Crataegus sinaica* fruits, leaves and flowers has been recognized to proanthocyanidins and other glycosylated derivatives of flavonoids (Mateos *et al*., 2012), such as vitexin (Sticher and Meier, 1998). Sugars, sugar alcohols, organic acids, and terpenes that are found everywhere between all plants are also regularly measured. Sugars are produced in the leaves and are transported to the vacuoles and free space in the fruit during its growth. The sugars that have been measured in the fruits of *Crataegus sinaica* include glucose, sucrose, fructose, and xyllose. Sugar alcohols, including sorbitol and myoinositol, have also been quantified. Hawthorn fruits have a particular importance, as it is the main translocating sugar (Urbonaviciute *et al*., 2006). Usually, sugars and sugar alcohols are measured in those hawthorn species that are more regularly consumed as food.

Malic, citric, succinic, ascorbic, tartaric, quinic, protocatechuic, 3- and 4-hydroxybenzoic, salicylic and syringic acids have previously been quantified in *Crataegus* species, along with a number of fatty acids measured in the fruits (Ayaz *et al*., 2002), an essential nutrient that humans are not capable to synthesize themselves, is effective as an enzymes cofactor and an electron donor/acceptor. Examples of enzymatic activity that could not occur without the existence of ascorbic acid include collagen biosynthesis, cholesterol catabolism, ATP production, and the synthesis of hormones such as norepinephrine. Also act as an antioxidant and aids in the prevention of diseases related to oxidative stress, such as cancer and cardiovascular disease (Davey *et al*., 2000).

Terpenes are the largest class of natural products and have a number of properties similar to those of other secondary metabolites. In plants, these compounds are widespread and may act as toxins, repellents, and attractants (Gershenzon and Dudareva, 2007).

**Figure (1b):** Location map of *Crataegus sinaica* in Saint Catherine Mountains Protectorate, Southern Sinai. Gebel (G) is represented by (▲), Wadis or valleys (W) and habitats of *Crataegus sinaica* represented by (•).
Traditional Treatments in Folk Medicine

Crataegus species (hawthorn) have been used usually since ancient times (Murray, 1995). It has been suggested that its antioxidant components make up its many favorable therapeutic effects. A decoction of leaves and undeveloped fruits are used as a cure for cardiovascular diseases, cancer, diabetes and sexual weakness in Arabian traditional medicine (Miller, 1998; Ju, 2005). In Mexico, diabetes is treated using hawthorn extracts. Such treatment may be of considerable benefit especially during the early stages of the illness (Rigelsky and Sweet, 2002; Ljubuncic et al., 2005; Khalil et al., 2008).

Side effects of Hawthorn were well accepted in studies lasting up to sixteen weeks. Some side effects, may have been related to hawthorn extracts cited in the literature are: mild rash, headache, sweating, dizziness, sleepiness, agitation, gastrointestinal complaints (Houser, 2006). The Drug interactions of Crataegus sinaica include the flavonoid components of hawthorn may be responsible for treatment of heart failure. However, these components may also affect P-glycoprotein function and cause interactions with drugs that are P-glycoprotein substrates, such as digoxin, which is also used to treat heart failure (Tankanow et al., 2003).

Pharmacological activities

Crataegus species possesses massive medicinal applications. Crataegus sinaica has been monitored for its biological activities Crataegus may develop coronary artery blood flow and the contractions of the heart muscle, therefore used widely in cardiovascular disorders such as arrhythmia, myocardial infarction, congestive heart failure (Garjani et al., 2000; Degenring et al., 2003; Long et al., 2006; Jayalakshmi et al., 2006). Crataegus extracts also prevents elimination of plasma lipids like total cholesterol, triacylglycerides, LDL and VLDL fractions (Andrade-Cetto and Heinrich, 2005; Ljubuncic et al., 2006).

Crataegus perhaps working as anti-inflammatory, gastro-protective, antimicrobial agent (Kao et al., 2005; Tadic et al., 2008) and used as hepatoprotective agent. It is also mildly inhibits angiotensin converting enzyme (ACE) and reduce production of the potent blood vessel-constricting substance angiotensin II, therefore act as hypotensive and diuretic (Schroder et al., 2003). Crataegus extract possess positive inotropic effect of amines such as phenethylamine, O-methoxyphenethylamine and tyramine. These amines were responsible for in vitro activity of Crataegus extracts on the guinea pig papillary muscle (Wagner and Grevel, 1982) and it also raised intracellular calcium thus prolongs the action potential, which supports for its inotropic activity (Kocyildiz et al., 2006). Flavonoids and proanthocyanidins are the main components responsible for the biological and therapeutic activity of Crataegus species. These flavonoids and proanthocyanidins show anti-HIV activity (Shahat et al., 1998) and antimicrobial activities (Cushnie and Lamb, 2005).

The antioxidant capacity of extracts of Crataegus plants which have long been used in herbal medicine for the cure of cardiac and circulatory functions has been considered. Crataegus sinaica has shown anti-inflammatory, gastro protective (Tadic et al., 2008).

Threats facing Crataegus population

As the Crataegus sinaica is recorded as endangered plant species. It is must be to conserve it to gradually increase the population number. The conservation state should be based on knowledge of the genetic composition and structure of Crataegus populations as well as an understanding of mating patterns within its population. Also, knowledge of the main challenges and problems that threaten Crataegus to extinction.

Hybridization plays a role in their evolution (Phipps, 1984). According to Pojarkova (1939), Gladkova (1968) and Christensen (1982 a, b, and 1984), hybridization, introgression, and subsequent polyploidy play a major role in the evolution of Crataegus in the Old World.

Unsustainable use of Crataegus represents one of the main causes of reduction in Crataegus numbers, as the Sinai Peninsula Bedouins have common knowledge of using plants for medicinal purposes. In recent years, knowledge of traditional medicine has become well known there, so that there is over-collection of medicinal plants from their native habitats. Overexploitation of many species eventually leads to their disappearance, resulting in threatening their existence. It is to be noted that some of these species are in official pharmacopoeia. As well as Crataegus branches are cut by natives for fire, as the hawthorn wood is very tough so it has the hottest fire, while the fruit is consumed due to its palatability.

Development pressures and human activities represent danger for Crataegus (e.g., encroachment, adaptation, agriculture, and mining). The area of the St. Catherine Protectorate is inhabited by more than 10,000 people, including resident Bedouins as well as newcomers for services, or and Bedouin settlements are added. Uncontrolled tourism poses a risk to the existence of Crataegus and other endangered plant species. Every day several hundred people attempt the ascent of Mount Sinai, mainly to view the sun rising over a breathtaking series of mountain tops. The impact of this sensitive site is considerable values. The major threats arise from a combination of inappropriate urban
development, an expanding resident and migrating population, changes in life-style, and deficiences in institutional planning. Tourism activates threaten the plant species for extinction danger, such as deformed landscape, localized overgrazing, disappearance of shrubby plants (for clearing the land, for fuel, or for sale if of medicinal value), damage by safari vehicles and depletion and contamination of the meager ground water resources. Also over-collection of Crataegus by botanists and scientists for scientific researches and studies is one of the causes of reduction of Crataegus numbers.

Moreover, the hawthorns are generally propagated by seed but both seed germination which is slow and difficult and mature tree cuttings which are difficult to root and rare to succeed (Bujarska, 2008; Nokes, 2001). The climate has great effect for distribution Crataegus. Temperatures and humidity increase from top to bottom and from mountains to the wadis. High temperature reduces the rate of seed germination, water scarcity and small underground water reservoirs increase the extinction danger of Crataegus in South Sinai.

Management and conservation

There is a continuing reduction in habitat quality for this species through time. Climate change plays role in decrease the population numbers (Grabherr et al., 1994; Root et al., 2003). This reduction observed in Crataegus sinaica is likely caused by climate changes in the past few decades and human activities. We need to work in different directions to protect this species from extinction: conservation through create genome reso-urce 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 (Zaghloul, 2008). It is necessary to carry out regular monitoring to keep updated on the population size, distribution and its trends.

Insitu conservation through work on rehabilitation and restoration the present population and create more fenced enclosures in the whole area in addition to the enclosure present in Saint Catherine Protectorate. It is important to expand and encourage sustainable use of plant species, control the unmanaged collection through Bedouin and also botanists and expand protected areas. Concerned experts must adopt public policies and environmental laws that promote protection and conservation of plant species, establish tax system for funding conservation and organize the uncontrolled tourism and tourist industry.

Raising the public awareness and establishment and improvement new educational systems in schools, universities and scientific research centers about the sensitivity of this important threatened species are one of essential points in conservation concept. Also support Bedouin with programs aiming to induce the Bedouin community to accept the idea of protection and conservation and participate in it.

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**استراتيجية المحافظة على نباتات الزعور كنوع من أنواع النباتات ضد التغير المناخي والنشاط السكاني في جبال جنوب سيناء، مصر**

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*Crataegus* من نباتات عائلة القناطير، ونحو 280 نوعًا من الشجيرات الشوكية المشابهة أشجار الصغير، حيث تزرو محتملًا هذه أنواع نباتات النشاط البصري الساكن في المناطق المعتدلة الشمالية في أوروبا وأفريقيا، وفي مصر يكثر وجودها على جبل سيناء، حيث يتم التخلص من الأودية المتفرعة في منطقة سانت كاثرين. هناك العديد من أنواع من الساقية، وتشتهر في الطب التشريعي لعلاج مشاكل القلب مثل ارتفاع ضغط الدم crataegus، والثدي القلبي، وعدم انتظام ضربات القلب وفشل القلب الاحترق، وفي الغالب تركز أبحاث أنواع crataegus على تحديد وتقييم كمية مركبات القلافونويد والأنثوسين، والتي تثبت أن لها نشاطًا دوائيًا. ولكن هناك اختلافات ملحوظة في جودة المواد لهذا النوع عبر الزمن، و من المرجح أن يكون هذا الاختلاف الذي لوحظ في نباتات الزعور بسبب التغيرات المناخية في العقود القليلة الماضية والأنشطة البشرية (walking ترعة القالب، والغذاء، والبرمجة مع الدهانين للثلاجة العلمي، والسياحة غير القبلية، وإنشاء مستوطنات البشر) ولذلك الإسهام نهدف إلى تقييم ضوء هذه التحديات التي تهدد سكان Crataegus، وتتم اقتراح خطط حفظ لحماية هذا النوع من الإفراص وأخيراً أجراء مزيد من الدراسات حول هذا النوع المهدده الظاهرة.