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Caralluma tuberculata - An important medicinal plant to be conserved

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Abstract

Caralluma tuberculata N.E. Brown is a perennial herb. It belongs to Asclepiadaceae family, mostly found in the mountainous regions of Pakistan. The plant is used as vegetable in cooked form, consumed as tea or used in the dry powder form or chewed fresh. It is of great medicinal importance. Many communities have used this plant - as folk medicine for years to cure various ailments such as stomach problems, diabetes, muscle pain and skin treatment and as appetizer. Modern research suggests that it can be used in the formulation of various drugs. The plant has been tested for its anticancer, anti-diabetic, antioxidant, antimicrobial activities and other ailments. The plant must be conserved for its health benefits. An effort is made here to briefly describe the medicinal value of this important plant and create awareness in the community regarding its conservation.

Key words: *Caralluma tuberculata*, medicinal plant, conservation

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Caralluma tuberculata - Korunması gereken önemli bir tıbbi bitki

Özet

Caralluma tuberculata çok yıllık bir bitkidir. Pakistan'ın en çok dağlık bölgelerinde bulunan Asclepiadaceae familyasına aittir. Bitki pişmiş halde, çay olarak tüketilmiş veya kuru toz halinde veya taze çiğnenmiş olarak kullanılır. Çok büyük bir tıbbi öneme sahiptir. Mide problemleri, diyabet, kas ağrısı, cilt tedavisi ve iştah açıcı gibi çeşitli rahatsızlıkları tedavi etmek için yıllarca halk hekimliği olarak birçok topluluk bu bitkiyi kullandı. Modern araştırmalar, çeşitli ilaçların formulasyonunda kullanılabileceğini göstermektedir. Bitki anti-kanser, anti-diyabetik, antioksidan, anti-mikrobiyal aktiviteler ve diğer rahatsızlıklar için test edilmiştir. Bitki sağlık yararları için korunmalıdır. Burada, bu önemli bitkinin tıbbi değerini kısaca tanımlamak ve topluluğun korunmasına ilişkin farkındalık yaratmak için çaba sarf edilmektedir.

Anahtar kelimeler: *Caralluma tuderculata*, tıbbi bitki, koruma

1. Introduction

Caralluma tuberculata is a member of Asclepiadaceae family. It is a perennial herb of succulent nature, mostly found in India and Pakistan and south east Egypt. In Pakistan, it is commonly known as pamanke and chunga, mostly consumed as vegetable in cooked form [1]. Stem of *Caralluma* sp. is normally erect, sometimes creeping or climbing. It bears a succulent stem with branches of tetragonal shape. The margins of branches are dentate which contain soft spines [2]. Usually it produces branches on the stem which reach up to 1 meter height. Flowers produced on the branches are soft fleshy, with star like structure. The flowers are umbel type formed at the base of plants. Blossoms of *Caralluma* normally gain 1.2- 6 cm height. The smell is not attractive [3]. The fruits are thin, flat and pointed at the apex [4]. *Caralluma* species are xerophytes and can survive under dry conditions for a long time. They show the Crassulacean Acid Metabolism (CAM) to survive in their natural environment. The plant possesses small stomata which enable it to conserve

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moisture under harsh conditions [5]. Most of the *Caralluma* species grow well in full sun, require good aeration, excess of humidity is avoided. It can be cultivated in the regions where temperatures are mild, but less than 10 ˚C is not recommended for its cultivation. It can be propagated through seeds but due to low viability, it is not practiced on commercial bases. The best method for it propagation is cuttings however; it can grow from division of roots. Sandy soil is best for its cultivation [6].

2. Nutritional status

C. tuberculata is composed of different types of essential nutrients. Ahmad et al. [7] have reported that it contains high amount of ash (14.08%) which has strong correlation with fats, proteins and energy. It has low amount of fats and energy, but high fiber content which is important to reduce cholesterol. Moisture content of the plant is very high as it is related to cactus species. It can tolerate drought stress. The extract contains 1.52% carbohydrates and 5.26% proteins. It also contains adequate amount of iron which plays a role in the hemoglobin and oxygen transport in the body [8]. Another essential element manganese is found as 25.667 µg/g, while potassium is 2706.7 µg/g and sodium 205.53 µg/g. The cadmium is 34.9 µg/g, copper 10.5 µg/g and lead 83.033 µg/g in the extract [7]. Adnan et al. [9] have reported that it contains ample amount of chromium, which plays an important role in the synthesis of insulin and hence is very effective in diabetes [8]. Similarly, zinc is also necessary for insulin and works as a cofactor for its production. It also improves metabolism of thyroid in human body. *C. tuberculata* contains high amount of zinc [10].

3. Chemical composition

The presence of glycosides adds to the medicinal importance of this plant. Various glycosides such as triterpenes, megastigmane, pregnane, saponine and flavone have been reported in *Caralluma* [11]. *C. tuberculata* contains numerous chemical compounds which include terpenes. Chemical analysis of its extract shows that it contains terpenes such as amyrin, α amyrin cinnamate, α amyrin acetate and lupeol, α and β. It also contains pregnanes, which include various type of caratubersides. Various types of sterols are also found in the extract mainly taraxasterol, β-sitosterol and its different glucosides [5]. Another important constituent of this plant is the presence of various flavonoids. It also has some bioactive secondary compounds including amino acids, terpenoids and tannins, reducing sugars, beta cyanins and steroids. Due to the presence of these secondary metabolites this plant is of high medicinal potential [12]. Other compounds such as anthocyanin, saponins, cumarine, betacynin, tannins and alkaloids are also found in *C. tuberculata* [5]. Similarly various types of fatty acids, hydrocarbons and the presence of some essential oils have also been reported [13]. Some the chemicals reported are listed in Table 1.

Table 1. Some of the important compounds isolated from *C. tuberculata*

Compounds	**References**
Ethanol, vitamin, phenolic content, carbohydrate, protein	[14]
Favone glycosides	[15]
Luteolin-4′-O-β-D-glucopyranosyl (2→1)-α-L-rhamnopyranoside	[16]
Caratubersides Steroids, terpenoids, reducing sugars, tannins, beta cyanin and amino acid	[17, 18]
3-O-β-D-glucopyranosyl-(1→4)-β-D-(3-0-methyl-6desoxy)-galactopyranosyl)-14-hydroxy14β-pregnane-20-one	[4]

4. Traditional uses as medicine

Caralluma species have been used in folk medicine for hundreds of years in the treatment of various ailments. Its traditional application is reported in curing of simple disorders such as cuts, cold and cough and some complicated diseases including malaria, diabetes and for the treatment of kidney stones. It has been used to improve digestion, as antipyretic agent, antirheumatic, anti-nociceptive, antidiabetic, anthelmintic, anti-inflammatory and antioxidant [19]. Extract of *C. tuberculata* also is used for suppressing appetite and is helpful in the improvement of central nervous system disorders [5]. Juice extract obtained from this plant is used locally in the treatment of various diseases including blood disorder, leprosy, diabetes and rheumatism [20]. In Saudi Arabia, it is traditionally used by diabetic patients. Similarly it is beneficial in the treatment of peptic ulcer. For the treatment of ear inflammation its extract has been used by applying drops to the ear [21]. It is also used for purification of blood, as a hypotensive agent and is very effective in the treatment of scorpion and snake bites [22]. Powder form of the plant is very effective in the treatment of hepatitis B & C. It has also been used for the treatment of stomach pain, dysentery and constipation, dried farm for curing of jaundice is taken with

water. Similarly, in fresh farm its paste is used for skin spots and pimples. It is also consumed as vegetable in cooked form [23]. For the treatment of liver disorders it is crushed, tea made and then given to the patients [24]. In various rural communities it is used as spice and also served in the form of chutneys with meals. Different species of *Caralluma* are used to make pickles. Labors eat it in raw form to get rid of appetite [25]. It is also helpful in improving the body strength and is consumed to reduce thirst. Migraine is cured by taking fresh juice of *Caralluma* and black pepper. In Iran, stems of *Caralluma* are mixed with honey for reducing kidney pain [26]. In Spanish communities, it is famous for its carcinogenic activity. Similarly, in Pakistan it is ground and mixed with water to cure jaundice [5]. Traditionally various skin problems have been treated with its pastes and extracts. Local people make different pastes for curing skin infections [27].

4.1. Muscular pain

Rauf et al. [17, 18] have conducted an experiment on the use of various fractions of ethanolic extracts of *C. tuberculata* to check its effects against muscle pain and its efficiency as tranquilizer as well as its atinociceptive activity. They have concluded that ethanolic fraction of *C. tuberculata* is very effective for use as muscle relaxant, antinociceptive and as a tranquilizer. Presence of triterpenes or sterols is responsible for the treatment of various types of inflammations. So, it can be accountable for anti-nociceptive activity of this plant [28]. Ramesh et al. [25] has reported that flavone glycoside present in *Caralluma* is found very effective to be used as anti-inflammatory and anti-nociceptive.

4.2. Diabetics

Diabetes is one of the physiological disorders that effects human activities and can damage various body parts [29]. Different species of *Caralluma* have been reported to cure diabetes. In India, *C. attenuate* is used in raw farm to cure diabetes [30]. It is cooked as vegetable and provided to peoples having issues of high blood pressure and diabetes. Wadood et al. [31] have reported that *C. edulis* and *C. sinaica* have the potential to reduce blood glucose level. In Pakistan it is locally chewed after meal in fresh farm for treatment of diabetes [32]. Najam-us-Saqib et al. [33] have also reported that high *Caralluma* extract concentrations significantly decrease blood sugar level. This decrease may be due to the insulin type activity of *Caralluma* or it may stimulate the synthesis of insulin. Sultan et al. [34] have conducted a study on the effect of various extracts and its fractions against induced diabetes in rabbits. They found that reduction in blood glucose occurred when extract is orally ingested to diabetic rabbits. Similarly, they observed that it also reduces body weight of rabbits when chloroform fraction was used. However, when aqueous and ethyl acetate fractions were used improvement in body weight took place while blood sugar level decreased. Poodineh et al. [35] have conducted an experiment to investigate the antioxidant potential of *C. tuberculata* stem powder. They induced diabetes in rats and then treated them with powder of *C. tuberculata*. According to their results decrease in the blood glucose level was observed in those rats fed with powder. The body weight was also affected significantly with increase in uptake, which was recorded in normal rats to which powder was ingested, however in diabetic rats gradual decrease was noted in their weight. While in the case of food uptake highest was observed in the diabetic rats, in control it was minimum. The antioxidant activity was also significantly affected by *C. tuberculata* powder. With increase in powder uptake free radicle scavenging capacity improves, which prevents cardiovascular diseases due to increase in total thiol.

4.3. Hypertension

Hypertension is one of the problem increasing day by day [36]. Different diseases such as diabetes, chronic kidneys disorders and obesity are the major components causing hypertension [22]. Similarly, insufficient mineral consumption, deficiency of vitamins especially vitamin D, alcohol intake and increase in salt intake are also responsible for hypertension. This leads to an increase in the risk of various cardiovascular diseases [26]. In many countries *C. tuberculata* is used in fresh farm, chewed as it acts as a blood purifier [5].

4.4. Gastrointestinal disorders

Diarrhea, ulcer, constipation and abdominal pain are the major gastro intestinal problems. Some *Caralluma* species such as *C. umbellata, C. edulis* and *C. tuberculata* have been reported to be used in the treatment of such ailments associated with digestive disorders. It is also helpful in gastric problems, improves activity of digestive system and also enhances hunger [37]. Marwat et al. [38] have reported that in powder farm *C. tuberculata*, when taken with water is very effective in curing various gastrointestinal disorders such as constipation, stomach pain, dysentery and other gastric problems. When cooked with meat, it is very effective in digestion process.

4.5. Rheumatism

Rheumatism is caused by inflammation, swelling, muscles and pain of joints. *Caralluma* species have the potential for use in the treatment of rheumatism. It is one of the major components of folk medicines in Africa for the treatment of rheumatism [39]. Naik et al. [40] have reported that three *Caralluma* species including *C. adesecnse*, *C. edulis* and *C. tuberculata*, are very effective in curing rheumatism. Extract of *Caralluma* is also effective in the movement of joints. It increases the production of synovial fluids, which is responsible for joint mobility and efficiency. It is used as a tonic, which strengthens the joints to bear heavy load [24].

4.6. Antipyretics

Studies have shown that different *Caralluma* species are antipyretic. These species have been used traditionally in folk medicine. *C. edulis* and *C. tuberculata* have been used against fever and reported to be very effective. Especially upper part such as stem of *C. tuberculata* is an effective antipyretic agent [41]. Similarly stem of *C. edulis* is considered as most effective in fever reduction [42]. Some of the traditional uses of *C. tuberculata* are listed in table 2.

Table 2. Traditional use of *C. tuberculata* in different farm against various ailments

Disorder	**Mode of application**	**References**
Peptic ulcer	Fresh juice	[43]
Freckles, pimples	Fresh plant is chewed	[23]
Ear inflammation	Juice as drops	[43]
Rheumatism, diabetes, antipyretic	Fresh juice	[20]
Jaundice, dysentery, stomach pain, constipation	Powder taken with water	
Hepatitis B & C, and Diabetes.	Cooked as vegetable	[23]
High blood pressure, Blood purifier	Tea	[22]

Plants are a vital source for the development of medicines to cure different human diseases [44]. Plants have various secondary compounds which are biologically active and strongly affect physiological processes of human body. Various chemicals extracted from plants have been used for making drugs [44-47]. In different communities, *Caralluma* has been locally used for the treatment of diseases. Recently, different *Caralluma* species have been tested against chronic human disease such as cancer. Researchers have reported several pharmacological uses of *C. tuberculata*, some of these are discussed below (Table 3).

Table 3. Biological activities of *C. tuberculata*

Activity	**References**
Antioxidant	[30]
Analgesic	[48]
Cytotoxic	[49]
Antifungal activity	[50]
Anti-inflamatory	[25]
Antimalarial	[17, 18]
Anti-trypanosomal	[41]
Phytotoxic	[51]

4.7 Antioxidant activity

Antioxidants are the compounds used to scavenge free radicles produced during stress condition in the body. These are helpful in the treatment of cancer, cardiovascular diseases, atherosclerosis and are also very helpful as anti-aging agent. Different species of *Caralluma* have been tested for its antioxidant activity [52]. Vajha et al. [53] have studied methanolic extracts of four *Caralluma* species for their antioxidant activity. They have concluded that all the studied plants contain phenolic compounds in high amount, which are responsible for their antioxidant activity. Similarly Rauf et al. [17, 18] have tested *C. tuberculata* extracts of various fractions of methanol and chloroform to evaluate free radicle scavenging activity. All the studied fractions of extracts have shown antioxidant activity. However chloroform extract has maximum free radicle scavenging activity as compared to other tested extracts. They also reported that it has very strong antioxidant activity because it contains high amount of phenols and flavonoids. Kumar et al. [30] have also reported role of *C. tuberculata* extract in antioxidant activity.

4.8. Antimicrobial activity

Humans and animals both are affected by microorganisms, ranging from light to sever. *Caralluma* extracts have been tested against different strains of microbes. Zito et al. [50] have used methanolic extract against *Salmonella typhi* and *Pseudomonas aeruginosa*. They found that *Caralluma* extract strongly inhibits the growth and development of both studied microorganisms. Similarly, *Caralluma* contains fatty acids which also have been tested for their antimicrobial activity. Results have shown that it is very effective against different microbes. Aqueous and ethanolic extracts have been tested against *Escherichia coli* and *P. aeruginosa*. Both extracts have proved significantly affective in the growth of both tested organisms. They strongly suppress colony development of both species [54]. Rizwani [16] has tested two species of *Caralluma*, *C. edulis* and *C. tuberculata* against different bacterial strains. He used ethanolic extracts and found it very effective. He concluded that ethanolic extracts of both species inhibit growth of gram positive and gram negative bacteria. Kulkarni et al. [54] tested methanolic extract of *C. tuberculata* against *A. niger* and *A. flavius*. The extract significantly inhibits growth of both tested species. However, strong inhibitory affect has been noted against *A. flavius*.

4.9. Anti-cancer

Various pregnane glycosides isolated from *C. tuberculata* extract exhibit cytotoxic activity against different human diploid cell lines [55]. These esterified pregnane glycosides have the potential for use in the formulation of drugs for curing cancer [56]. Different types of cancers have been reported that affect human body. Colon cancer is one of them having the potential to spread in various body parts such as lungs, ovaries, liver and other organs. It is treated with oxaliplatin and 5-flourouraci [48]. But use of synthetic drugs has adverse effects on human body. So, there is a need for plant based natural products for its treatment which has no side effects [57]. Ethanolic extract of *Caralluma* has been tested for its cytotoxic effects against lung cancer. It has been found to have significant effect against colon cells. It may be due to the presence of pregnane glycosides which is helpful in apoptosis induction. So, it can be used in the formulation of drugs for the treatment of lung cancer [49]. Similarly, Priya et al. [58] have also reported that *Caralluma* extract has the potential for use in curing of different types of cancers. They have further stated that it is due to the presence of flavonoids and phytophenols which inhibit growth of colon cells. Waheed et al. [14] have used *C. tuberculata* extract in different fractions of ethyl acetate to check the ability of extract against different abnormal cell lines of various types of cancers. Results have revealed that it is the most effective anti-proliferative agent against breast cancer. This anti-proliferative activity of the extract is due to the presence of steroid glycoside compound present in *C. tuberculata*.

4.10. Toxicity

Najam-us-Saqib et al. [33] have conducted a study to check the acute and chronic toxicity of various ethyle acetate fraction extracts of *C. tuberculata*. They used various albino types of mice for this purpose and gave different concentrations of extracts according to their body weight with time intervals of 30, 60 and 90 days. From the experiment they concluded that body weight of mice increases significantly. *C. tuberculata* extract has not been effective in inhibiting normal growth and development of body. They have also suggested that *Caralluma* extract encourages the production of body proteins. Ahmad et al. [43] have reported that its extracts increase hunger, so due to increase in food uptake body weight also increases. Similarly reduction in blood sugar level has been recorded when chronic treatment is given to mice. This indicates that it is effective in reducing glucose level of blood especially indiabetic patients [33]. Rauf et al. [17, 18] have studied *C. tuberculata* extract in different solvents such as n-hexane, ethyl acetate and chloroform. They used various concentrations of extracts to investigate its phytotoxic activity. From the results it was concluded that it inhibits growth of plant cells and hence is strongly phytotoxic. They further concluded that maximum phytotoxicity was noted in ethyl acetate fractions, followed by n-hexane while minimum was recorded in chloroform fractions. Abdel-Sattar et al. [51] have used *C. tuberculata* extract against *Lemna minor* to evaluate phytotoxic activity. They reported that it has strong phytotoxic activity and can be used in the formulation of natural herbicides. Methanolic extract also restricts germination and growth of rice. Ahmed et al. [15] have studied various fractions of methanolic extracts against different types of cancers and concluded that it consists of some compounds which are cytotoxic. So, it can be used as antitumor agent against several types of cancers.

5. Current status, local trade and future perspective of *C. tuberculata*

C. tuberculata is an important medicinal plant. In developing countries like Pakistan, people give preference to the natural sources of remedy against different diseases. The plants are mostly used in fresh form or dried because the recipe is very easy and is less toxic for humans. Pakistan does not meet the requirement of the plants used in the preparation of herbal medicines. For this purpose, herbal preparations are imported from different countries such as China, India, Sri Lanka, Kenya and Nepal [59]. Hussain [60] has conducted a study on the present status of some important medicinal plants of northern regions of Pakistan. He has reported that *C. tuberculata* is one of the endangered medicinal plant species. Afghan refugees collect it from Waziristan region and sell it in the nearby markets for livelihood. Similarly,

local people of the area keep on collecting the plant from their natural populations. Most of them have no knowledge about its growth habits and biology. They bring it to the local market where it is sold at the rate of US$ 3/kg. Some of them take it to the city markets, where its price is about US$ 5/kg. Adnan et al. [5] have reported that some of the pharmaceutical companies are interested in its collection. It is expected to be used in the formulation of various drugs. Nearly 4 million people use traditional medicines against different ailments globally. Trade of these herbal remediation is increasing day by day. This increases the demand of medicinal plants and their harvesting. Due to overharvesting some of the medicinal plants including *Caralluma* sp. are under high pressure. *C. tuberculata* is the most endangered medicinal plant due to its improper picking from its wild populations [61]. Tareen et al. [24] have conducted a study to investigate the indigenous knowledge of some medicinal plants. They have reported that inadequate harvesting, deforestation, overgrazing and urbanization are the major threats to the wildly growing important medicinal plants. It is a source of income for many people. Similarly high demand of *Caralluma* sp. species from the pharmaceutical industries, food and herb products dealers and general public are putting great pressure on this plant as well. It is therefore necessary to look into the conservations measures to meet the market demand. Recently, several governmental organizations have started research activities to domesticate this plant. In addition, the farmers are trained to cultivate this medicinal plants in home gardens and for commercial use.

6. Conservation strategies

Micro propagation is one of the tools for the conservation of endangered medicinal plant species. The in-vitro produced plants can be planted in their natural environment. Through this technique, researchers modify its growth habits and can cultivate it in other environments where it can easily acclimatize [62]. For this purpose there is great need to set up farms for medicinal plants. These will provide awareness about their cultivation and conservation. Other possibility is to conserve by introduction in the botanical gardens. Proper management approaches are required to preserve valuable medicinal plants. Their cultivation should be increased by providing proper guidance to the farmers and local community. We can conserve *Caralluma* sp. species by identifying suitable areas for cultivation and multiplication. The population can be increased by providing awareness among the local people to grow it in or around their houses. Proper education about its growth habit and multiplication is important, which should be provided to the local pickers of this plant. If steps are not taken for the conservation of this important plant, it will be lost forever.

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