

Review Article

A Review on the General Features, Current Status, Opportunities of Threatened Yeheb (*Cordeauxia edulis* H.) Plant in Ethiopia

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Abstract: This paper reviews and discusses on the general features, current status and opportunities of threatened yeheb (*Cordeauxia edulis* Hemsl. Plant in Ethiopia. The literature review was done by collecting relevant information from journal articles, books and electronic resources. The review sums up the following key points on the general feature, current status and opportunities on yeheb, (1) it is a multi-branched evergreen shrub and a drought resistant and desertification tolerant plant, (2) it is threatened with extinction from most of its habitat and deserves careful protection and detailed tests in cultivation and (3) In view of great danger of its extinction, different measures have been suggested to preserve *C. edulis* and improve its production.

Keywords: Yeheb, *Cordeauxia edulis*, Threatened, Conservation

1. Introduction

Cordeauxia edulis Hemsl., locally called yeheb, is a multi-branched evergreen shrub that belongs to the family Fabaceae or Leguminosae [1, 4]. It is highly branched bush with thick and vertical branches, with an average height of 2-3 meters but it can grow up to 4m high in sheltered spots. It has a taproot system up to 3 m deep with small secondary rhizomes near the surface and nodules on younger roots [36]. *C. edulis* is a drought resistant and desertification tolerant plant. For optimal plant development, average temperature and rainfall requirements are 25°C – 28°C and 85-400 mm/year, respectively [12]. It grows on red, alkaline, low nitrogen content, fine to coarse sand or grit to loamy textured, sandy soil [9, 42]. *C. edulis* prefers elevated stands, where no water accumulates.

C. edulis is an endemic plant species in the arid and semi-arid areas of Somalia and Somali regional state of Ethiopia. It was first documented by the Italian, Robecchi, in 1871 when exploring Somali-land [27]. It is a multi-purpose plant where most parts of the plant are used. It is an evergreen shrub and produces seeds called Yeheb nut [20]. The seeds are

edible and eaten fresh, roasted, boiled or dried [39]. The nut is the staple food for the local people which is similar to the common diet of rice and dates [21]. The seeds of this species is potentially available protein source with high sugar and fat contents. According to Gutale and Ahmed [16]; the seed of yeheb contains 37% starch, 24% sugar, 13% protein, 11% fat and various minerals. It has also high energy value (0.39-1.87 MJ/Kg) [28]. Sometimes the seeds of *C. edulis* is the only available food for Somali pastoralists during droughts. The leaves of *C. edulis* are also used to make tea. They are rich in energy; [28], extracted up to 5.86 MJ / Kg of dry matter. Although the shrubs cannot withstand long-term grazing pressure it serves as fodder for camels, goats, sheep and cattle in dry season.

It is essential for the livestock production, especially in central Somalia and eastern Ethiopia where *C. edulis* can cover 85% of the good-quality feed during the dry season [12]. As the wood of *C. edulis* is termite resistant; 90% of the houses in the pastoralist community of Somali regional state of Ethiopia are built from the wood of this plant [45]. In

addition, the woods are good source of fire wood it can burn well even when it is wet [45]. Furthermore, *C. edulis* serves for soil conservation and mulching, fixation of nitrogen, live fence, tannin dye, medicine to regulate gastric secretion, and bee forage [5]. On the contrary, the size of the wild population of *C. edulis* in its natural habitat is reported to decline rapidly, owing to habitat fragmentation, overexploitation, a low rate of regeneration etc. In line with, the species has been classified as endangered species by the International Union for Conservation of Nature [8]. This review aims to document scientific data on the general characteristics, current status, and the gap that causes the eradication of the plant.

2. Origin, Taxonomy and Botanical Description

2.1. Origin

The species of the genus *Cordeauxia* is distributed in two centers of origin which is the semi-desert region in the Horn of Africa, where rainfall is only 150-200 mm a year [41]. One is the South-eastern Ethiopia and the other extends through Central Somalia. It is cultivated on a small scale in Somalia and near Voi in Kenya [8]; where it was introduced in the 1950s. It has been introduced on an experimental scale into Sudan, Tanzania, Yemen, Israel [14] and in the United States [14], all with poor response. During a trial to establish plants in Israel only one of four sites succeeded, probably due to the climate or the biological factors may have been unsuitable [32].

2.2. Taxonomy

Cordeauxia edulis Hemsl. belongs to the family Fabaceae or Leguminosae; the subfamily Caesalpinioideae, and the only species within the genus *Cordeauxia* [1, 4]. In July of 1907 Captain Cordeaux, Commissioner Somali-land Protectorate, sent a sample of specimens from Ogaden province, Ethiopia to the Royal Botanical Garden for species identification. The samples proved to be leguminous, belonging to an undescribed genus in the tribe of Caesalpinieae, closely related but very distinct from *Schotia* and *Stuhlmaniania* [28]. To commemorate Captain Cordeaux successful work, [18], named the new genus *Cordeauxia* and gave the species epithet *edulis*, meaning "edible".

C. edulis has several common names; [4] reported the following spellings: ghieheb, giaebgiaheb, gieheb, ieebb, iee-ep, ieheb, iieb, jeebb, jieheb, ye'eb, yee-ep, yeheb and yehip; phonetically they express similar sound.

Two different forms/varieties of *C. edulis* are recognized, usually in pure stands [13]. The Suley ('Sulei) form is shorter, usually less than 1.5 m with an open spreading growth habit and ovoid sweet tasting seeds of 1.8g. It is pale green with large leaflets and stem diameter and the pods contain several smaller seeds [8]. The Moqley (Mogollo) form is more common, taller and erect with less sweet seeds of 1.3 g [6, 14]. It is dark green and has small leaflets and stem diameter and the pods contain one large seed [8].

2.3. Biology of *Cordeauxia Edulis* Hemsl

2.3.1. Root

C. edulis has a long, massive root system [31]. The long taproot has small secondary rhizomes near the surface [14]. The fast growing tap root can reach depths of 3 m in search of moisture and massive root system makes the bush remain green all year round [31]. These lateral roots develop at 10-40 cm under the soil surface and are up to 2.5 meters long [8]. The taproot makes it difficult to grow yeheb in a nursery; if it breaks the plant will die, and it is therefore recommended to plant the seed in field directly [14].

The information differs whether *C. edulis* has nodules or not. Booth and Wickens [6] reported the presence of nodules on younger roots but Assefa et al. [3] did not find any nodulation on roots neither, in field excavations nor in rhizobial occultation trials in containers.

2.3.2. Leaves

Leaves are leathery, pinnate with red glands on lower surface and 1-3 up to 5-6 pairs of leaflets depending on form [4]. The glands produce chemicals that can be used as a dye. Lister et al. [25] determined the chemical constituents of these glands to be a derivative of naphthazarine which was named *Cordeauxiaquinone*. This red pigment, *cordeauxiaquinone*, which by handling or when touched stains the hands red [4]. The leaves contain 0.7-0.8% of this substances [4].

The dye is selectively deposited in certain tissues of livestock which feed on *C. edulis* leaves; in particular their bones become stained orange or red. Nomads believe the meat from these animals tastes better than those that do not feed on *C. edulis* [23]. The leaves of *C. edulis* have an extremely thick cuticle and mesophyll consisting of palisade cells with lateral walls capable of folding in a concertina-like way. Therefore, the leaves are able to survive during long periods of drought and to quickly store water when available [8]. The leaves exist for more than one season, but the lifespan of individual leaflets are not known [10].

2.3.3. Stem

Stems of *C. edulis* are numerous, emerging, much-branched, forming a tightly bunched crown [28]. Mature plants may reach a height of 1.6 m while a few grow to 2.5 m in favorable locations, but usually it is not taller than 1.6 m because of grazing [21]. In places where it has not been grazed the height of *C. edulis* has been reported to reach 3 to 4 m [4, 40]. The stem has conspicuous red glands [8].

2.3.4. Flowers

Flowers are bisexual and bright yellow with 4-6 cm long as a whole. They are 2.5 cm in diameter, with 5 spoon-shaped petals and 10 straight stamens with hairy filaments at the base. The calyx has 5 green sepals covered with red glands similar to those of the leaves [4, 17]. The ovary is short stalked with a terminal dense stigma [15]. The inflorescence of *C. edulis* is a corymb formed at the tip of each branchlet [4]. The pollination is reported to be by insects which are not known but floral parts fall soon after pollination leaving only the fertilized

ovary [45]. Depending on rainfall, fruits normally take 10 - 14 days to mature but it can remain undeveloped up to 4 - 5 months waiting for rains and then they can develop and ripen within 5 - 6 days [6].

2.3.5. Seeds

Depending on growing conditions, plants may begin production of pods by the age of 3 years and may yield prolifically under favorable conditions by the age of 4 years [21, 31]. The longevity of the plant is estimated to exceed 200 years [19]. The pods contain 1 - 4 round or ovoid seeds, mistakenly called nuts, 2.0 - 3.5 cm long with an average weight of 1.6 gm [14, 33].

The seeds of *C. edulis* could be attacked by different kinds of weevils and moth larvae. Non crop specific, storage pests such as dried fruit beetle, flat grain beetle, rust red flour beetle, tropical warehouse moth and Mediterranean flour moth have been found in seeds. There are no reports of fungal, bacterial, viral or physiological diseases [6]. The seeds are tasty and nutritious, and are eaten by nomads either raw, roasted or cooked [15]. Seeds make a nourishing and balanced diet. Even though their protein and carbohydrate contents are less than those of most other pulses, the seeds contain both sugar and fats. They contain 11% fat, 13% protein, 24% sugar, 37% starch, and they also contain various minerals [16]. Another work, on the nutritional value of *C. edulis* seeds shows that its proteins contain amino acids in a proportion similar to that of grain legumes [15, 34, 35]. Local tradition suggests that the seeds were the staple food item of the nomads and relatively small quantities of the seeds enter the commercial trade through the local and regional market [21].

2.3.6. Propagation

C. edulis reproduce by means of the seeds which germinate rapidly after dispersal, between a few days and up to two weeks [6, 19]. Since the seeds are quite large and heavy they will germinate close to the mother plant [37]. The maximum germination rate for *C. edulis* has been reported to be more than 80% in a nursery situation but the seedling survival rate was low [21]. However, seedling establishment has been reported to be poor, perhaps due to excessive root growth [4]. Studies on seed storage behavior and germination indicated the fall of germination rate up to 41% when the seed moisture content is decreased to 9.6% [24]. In addition, Yohannes [45] reported that supply of different levels of nitrogen and phosphorus fertilizers couldn't alter the survival rates of seedlings. In general nursery production from seeds is complicated and difficult since tap root is fast developing and the plant will die if it is broken [6, 14, 21, 32].

It has been shown that exposed secondary rhizomes may regenerate vegetatively [29]. Vegetative propagation by cuttings can be used, but no information about how successful the method is have been found; cut end is to be treated with fungicide and growth hormone and the rooting is induced under mist propagation [6]. Some pilot studies have been made regarding micro propagation but so far without greater success [44, 45].

2.4. Distribution and Ecology of *C. edulis*

Native distribution area of *C. edulis* is restricted to open bush savannah in arid, semi-desert regions of Central Somalia and Ogaden region in Ethiopia [14, 21]. *C. edulis* is found to grow at an altitude of 100 - 1000 m.a.s.l on sands locally called 'haud' [6]. "Haud" is a region which includes the northeastern corner of Ethiopia, and northeast of Mataban and southeast to Jesomma of Somalia [6, 7]. The natural distribution of *C. edulis* is frost free with mean annual temperatures of about 28°C and mean annual rainfall ranging between 85 and 400 mm with two rainy seasons, one more reliable in March - May and another one in October - November [11]. Little is known on current distribution of *C. edulis*, however earlier travelers reported that yeheb areas are now considerably reduced and that the shrub has disappeared from many regions. This impression appears to be borne out by other recent collectors like Hemming [17] who seem to have encountered it only between Scillavo and Wardere in the Ogaden region of Ethiopia. The enquiries made in Galkayo, Somalia, where Well by and Gilligan as well as Drake-Brockman had found it in earlier years, elicited that the nearest locality was now some 50 miles away to the north-west, south of Bohotleh, in the neighborhood of Boh, the very region when Capt. Cordeaux obtained his botanical specimens [45].

The decrease may be partly due to continuous overall deterioration of the vegetation throughout Somalia and neighboring countries brought about by increasing livestock populations, droughts and wars. Exploitation of the shrub for its seeds as food, and uncontrolled livestock browsing undoubtedly has contributed to its decline [4, 21, 23]. The plant is adapted to nutrient impoverished soil [12, 36]. Plants are never found in alluvial flats with moist silt or near water since it's intolerant to water logging [6]. Its requirements for fertility are low; rather infiltration of rain water is very favorable [30]. Plants can withstand extreme drought and water stress causes leaves to fold (in roll) and, in extreme conditions, to fall [6].

Little progress has been achieved in introducing *C. edulis* outside of its natural habitat [33]. It had been introduced in trial plots in Kenya, Sudan, Yemen [14, 41], India [41], Australia, Israel, Tanzania, and United States of America [14] but with low success of establishment.

2.5. Importance of Yeheb

C. edulis has both ecological and economical importance for the region. It is a strong well adapted species in the arid environment. Although it did not flower, *C. edulis* survived even during the extreme drought years of 1973 - 76 [21]. *C. edulis* represents a large component of high quality dry season feed because of its evergreen nature [22]. And other researchers indicate that *C. edulis* is one of the valuable natural resource of Somali pastoralist which can provide food, forage and other important products. Mussa [30] reported that *C. edulis* used primarily as food (99%), followed by construction (89%), forage (86%), fuel (80%), fence (76%),

and medicine (68%). This indicates that all parts of this plant are highly used by the local people.

Food value: The seed/nut is edible, and is rich in nutritional value: high carbohydrate (36%) and fat (13%) contents [30]. The seeds are eaten dry, fresh, roasted or boiled and its tasty seed with smooth consistency is comparable to cashew, macadamia, pistachio or hazelnut [8, 13, 44]. The raw seeds contain a considerable amount of serine protease (trypsin) inhibitors, causing nausea or stomach distress and these inhibitors are destroyed by heating during cooking or roasting [28].

Livestock feed: Mussa [30] ranked the preference of yeheb by livestock. Accordingly, it is highly preferred by camel throughout the year, followed by goats, and least preferred by cattle. Goat and cattle browse it only during the dry season. However, camels are the dominant grazers of yeheb foliage throughout the year. Since pastoralists in the area are known for rearing camels mostly, yeheb plays a vital role in the region because of its availability during both the dry and wet seasons. Fodder value of the leaves is the same as other tropical tree legumes but some mineral levels (P, Mg, Mn and partly Zn) was not satisfy the demands of animals while yeheb were the only source of fodder [12]. The meat from animals fed on yeheb is particularly tasty and the teeth and bones of foragers become stained to bright orange due to the cordeauxia quinone present in leaves [38].

Medicinal value: The medicinal value of yeheb is well recognized, and it is argued that pigment from yeheb deposited in bones might stimulate hemopoietic tissue to produce erythrocytes directly and indirectly, and that cordeauxia quinone might be medicinally useful to stimulate hemopoiesis. Cordeauxia quinone is said to regulate gastric secretion and to treat burns [8].

Market value: Yeheb seeds are sold in local markets between US\$0.80 and US\$2.30 kg⁻¹ and contribute to household income ranging from 50 and 56% in all districts of Warder Zone in the Somali National Regional State of Ethiopia [30]. Seeds are exported from Ethiopia to Somalia and Arab countries, but most seeds are consumed locally [8]. Yeheb seed has high demand, and currently the demand exceeds the supply due to rapid diminishing of the plant population. In times of drought and famine, yeheb are usually one of the few natural foods and feed sources that are available for the Somali Pastoralists [26].

Other uses: In general, the species has multiple benefits including: source of bee forage, mulch for soil conservation, livestock fences and nitrogen fixation [5]. And also the wood is a good firewood, even when wet. Other economical values include the pigment in the leaves that is easily extracted and used as a fabric dye [7], for insect defense, and soap making. The leaves of *C. edulis* have been used to dye cloths, calico and wool since the cordeauxia quinone forms vividly colored and insoluble combinations with many metals [6].

2.6. Current Conservation Status of Yeheb

C. edulis is threatened with extinction from most of its habitat and deserves careful protection and detailed tests in

cultivation. There is little known about the biology, productivity or forage quality of *C. edulis*. Even if the spices has many importance and has the potential to play a role in ensuring food security both in its center of origin and diversity, the plant is threatened with extinction due to different factors. Unlike many other plants, yeheb shrubs flowers just before the onset of rains and the seeds mature when the plant moisture content is at its peak and this is one case for the decline and progressive destruction of the plant [8].

Yeheb seeds have been reported not to retain viability for more than a few months, even if they are stored under ideal conditions and it is another cause for redaction of yeheb [24, 30]. Another cause for the decrease of *C. edulis* is the loss of seeds removed through the local people, eaten by wildlife and destroyed by insects [1].

Some authors Hemming, [17], and Bally [4] reported the decline and progressive destruction of yeheb is due to over grazing, over exploitation during dry season, cutting, fire and also overharvesting of the seeds. In addition, erosion, drought and war in the region has led to poor or none natural regeneration [2, 3, 6, 14]. Yeheb is listed as rare in the 1997 International Union for the Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Plants. The definition of rare is “taxa with small world populations that are not at present considered endangered or vulnerable, but are at risk” [8].

2.7. Recommendation for Conservation of Yeheb

In view of great danger of its extinction as result of overgrazing, unsustainable utilization and bad regeneration different measures have been suggested to preserve *C. edulis* and improve its sustainable utilization. The suggestions that given by different researchers are the following - Protection of *C. edulis* shrubs largely depends on solving causes of species degradation through well designed conservation strategy. It's obvious that this species dominantly found in range land ecology where overgrazing is serious problem for biodiversity conservation and too for yeheb. Pastoralist community which with fences and to grow them in nurseries, develop a protocol for the in vitro germination and shoot induction of *C. edulis*, rapid in vitro propagation method is necessary for mass production of healthy and excellent *C. edulis* planting to rehabilitate the ecology of yeheb grown area and save the spices from extinction. Protection of natural stands and cultivation in afforestation projects, in and outside its native region is required, future researches on reproduction systems is recommended because yeheb has low seed set and does produce small amounts of viable seeds, further studies on pollen and seed dispersal are needed to understand the mating system of yeheb. Researchers, policy makers and other stakeholders need to come-up with sustainable use and conservation strategies. And the main focus of this review is that after understand the general feature and current status of yeheb plant in order to identify and arrange the appropriate methods that used to conserve and recover the plant together with the local society.

3. Conclusion

In general from this review we can conclude that *C.edulis* is very important plant during dry season and now a day this plant under critically endangered. As a result all the local community and all the concerned body should be try to developed different conservation strategy protocol and conserve the plant ether ex-situ or in-situ method based on the plant character.

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