V *Catha edulis* (Khat): In Vitro Culture and the Production of Cathinone and Other Secondary Metabolites

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1 General Account

1.1 Distribution, Botany, and Morphology

Khat, *Catha edulis* (Vahl) Forssk. ex Endl. (Celasteraceae), is an evergreen shrub or tall tree that may reach up to 25 m in height if not pruned (Fig. 1). Extensive pruning makes it a small shrub, as it is usually described. Its life span may extend for 40 years. The plant is indigenous to East Africa and southern Arabia, but may have originated in the Harar district of Ethiopia, according to earlier reports (Getahun and Krikorian 1973). Its habitat extends from northern Ethiopia to the mountainous regions of East Africa and Yemen, all the way to south Africa, between latitudes 18°N and 30°S. It is cultivated mostly on hillsides and mountain slopes at altitudes of 1500–2000 m above sea level (Nordal 1980; Krikorian 1984). Besides Ethiopia and Yemen, the khat plant is now grown in Djibouti, Somalia, Kenya, Tanzania, Uganda, and Madagascar. However, the use of the plant is by no means restricted to the natives of these countries, but extends to other Asian countries and immigrant communities in several Western countries (Kalix 1990).

The fact that the khat plant is not allowed to produce seeds and is mainly propagated by cuttings, and that only fresh leaves are used, may have confined its cultivation to the regions of origin and neighboring areas. In these regions, khat is known by different names, e.g., chat, tschat, qat or gat, Mirraa, murraa, etc. depending on the language of the region (United Nations 1978).

Both earlier and more recent investigations on khat revealed similar observations on the important morphological features that may assist in the identification of khat from various geographical origins. The leaves may vary in shape, size, and color according to degree of development and botanical origin (Shadan and Shellard 1962; Nordal and Laane 1978; Nordal 1980). They are simple, ovallanceolate in shape with acute apex and base, and are serrated along the entire margin except for a portion of the lower base. They are opposite or alternate in arrangement, and measure 4–11 cm long and 1.8–5 cm wide at the widest part. The youngest leaves are tender, thin, glossy, brownish green in color while the older ones are bright green, fibrous with clear pinnate venation, and sometimes with red rust-like spots. The leaves are odorless and have an astringent taste.

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Nordal (1980) described the flower of khat as the smallest within the dicotyledons. The flower is hermaphrodite, carried on a short peduncle, and consists of five sepals, five yellowish white petals, and five stamens. The fruit has an average length of 8–10 mm and a diameter of 2–3 mm. The fruit has three or four carpels and is six- to eight-loculate, but only two or three small, brown seeds develop in the fruit.

1.2 The Khat Habit

The habit of chewing khat leaves is a deeply rooted and widely accepted social tradition among the inhabitants of Yemen and Ethiopia. This is particularly dealt with in a comprehensive review by Krikorian (1984). The chewing is commonly practiced in groups. The participants gather daily or frequently during the week for 2 to 4 h, in what may be called a khat party or session. Both men and women chew in separate or mixed groups, depending on the culture of the region.

Khat is sold in bundles of fresh branches (30–40 branches/bundle) which are carefully wrapped in green banana leaves (Fig. 2) to preserve their freshness. The youngest leaves and tender twigs are stripped off the branch and chewed. The juice is swallowed with the saliva and the residue of the leaf material is stored in the mouth, forming a bulge in one cheek for the whole period of chewing. Cold soft drinks are usually taken to nullify the feeling of thirst normally experienced during chewing (Tariq et al. 1993).

On the average, each person consumes 100–200 g of fresh leaves, i.e., one bundle in one session. At the end of the session, the stored material is ejected.

1.3 Effects of Khat

Ever since khat was known it has been said to alleviate hunger and fatigue. This has recently been explained on the basis of its stimulation of the central nervous system (CNS). As a result, the consumer of khat experiences a state of euphoria, mental alertness, and excitement. Many khat users admit an increased intellectual ability, enhanced depth of perception, and feelings of grandiosity (Kalix 1990). These effects are felt during the session, which may be prolonged as a result. After the session the characteristic effects are anorexia, insomnia, depression, gastritis, and constipation (Halbach 1972; Lugman and Danowski 1976; WHO 1980). The latter effects could be due to the high tannin content of khat leaves, which are known to interfere with the absorption of proteins (Butler 1989), and are also increasingly implicated in esophageal cancer (Morton 1979, 1989). Beside its reinforcing effects, khat is said to be a folk remedy for asthma, bronchial disorders, flu, cough, and lethargy (Duke 1985).

It has been claimed that khat increases sexual desire (libido), but may also inhibit the performance and be inhibitory as well (Halbach 1972; Al-Meshal et al. 1985). Long-term habitual use may lead to impotence and spermatorrhea (Kalix 1990). Also, khat extracts have been shown to increase sperm abnormalities in male rats, decrease sperm count and motility, and reduce female fertility in mice and rats (Qureshi et al. 1989; Tariq et al. 1993).