DRIED KHAT

Recently our laboratory has received some dried plant material suspected of being khat. Our khat procedure was developed to analyze fresh khat samples. This is the form that khat is normally seen in the laboratory. Upon searching the literature I found that references to dried khat have been made for a long time. It has apparently been seen in other parts of the country recently. It appears that the cathinone does not degrade in the dried samples as it does in the fresh wet samples. This is probably the reason that we are beginning to see khat in this form.

Our procedure calls for homogenizing 10 grams of sample in a blender with 100 mls of 0.1 N HCL for 5 minutes. The sample that we received did not weigh enough for us to use 10 grams. Instead of using 10 grams we ground an aliquot of the dried material in a mortar with 0.1 N HCL. The sample was then filtered into a test and made basic with 1N sodium hydroxide and extracted into a small amount of chloroform. There was no need to dry the small amount of chloroform or evaporate it. The analysis was conducted on this chloroform extract and an excellent mass spectra and vapor phase IR was produced providing proof that both cathine and cathinone were present in the sample. The same reagents and extraction was used for this analysis, only the amount of sample and reagents used were different. The smaller amounts of reagents used made it unnecessary to dry and evaporate the chloroform.

Phillip W. Freeze 6/7/04

Phillip W. Freeze
Forensic Scientist Supervisor

NDIC Comment: Seizures of LSD laboratories in the United States are rare. According to NCLSS seizure data, law enforcement officials seized one LSD laboratory in Kansas in 2000, one in Missouri in 2002, and one in California in 2003. Most LSD available in the United States is produced primarily in Northern California and the Pacific Northwest by a relatively small network of experienced chemists; however, independent dealers throughout the country produce the drug in limited quantities.

* * * * *

- INTELLIGENCE BRIEF -

"GRABA" (DRIED KHAT) SEIZED IN KANSAS CITY

[From the NDIC *Narcotics Digest Weekly* 2004;3(13):3
Unclassified, Reprinted with Permission.]

Missouri: On March 4, 2004, officers from the Kansas City Police Department seized three bundles of khat and three small plastic bags filled with a dried form of khat, known as graba, from a Kansas City apartment. Officers went to the apartment after receiving information that several Somali males at the apartment were in possession of khat. An officer knocked on the door of the apartment and, when one of the occupants opened the door, the officer observed several males holding a green leafy substance that he recognized as khat. When the individual who opened the door realized that police were present, he immediately tried to shut the door. However, three officers entered the apartment based on reasonable suspicion that a crime was occurring. Officers conducted a search of the apartment for additional individuals, during which time officers discovered a total of six men as well as three bundles of khat and two plastic bags filled with graba. Officers also requested and obtained consent to search one of the suspect's vehicles, where he located an additional plastic bag filled with graba. According to the Kansas City Police Department, the availability of khat leaves has declined in the Kansas City area. At the same time, the availability of graba has increased. This is at least the third time this year that Kansas City Police Department officers seized graba. On January 4, 2004, officers seized 13.2 pounds of graba from an Ethiopian national and on January 28, 2004, officers seized 38 grams of graba from a Somali national.

NDIC Comment: Graba, often similar in appearance to marijuana, usually is produced in Ethiopia and commonly is dried before it is transported to the United States. Graba, like fresh khat leaves, contains cathinone, a Schedule I drug under the Controlled Substances Act; however, according to DEA, cathinone in khat begins to degrade 48 hours after the plant has been cut. Conversely, the Kansas City Regional Crime Lab reports that dried graba leaves maintain their cathinone content for an extended period of time. Unlike fresh khat, graba does not need to be kept moist prior to consumption, making graba easier to transport and package.

[Editor's Notes: To clarify the apparent ambiguity between the DEA and Kansas City Regional Crime Lab statements, cathinone begins to degrade in fresh cut leaf within 48 hours, unless it is refrigerated or dried. Most of the khat seizures in this country are of fresh leaf, wrapped in a combination of moist paper and banana leaves or similar, and often shipped in coolers. The

appearance of "graba" in the U.S. may be in response to the loss of potency in the fresh resulting from degradation during extended shipping and/or Customs delays.]

* * * * *

CORRECTIONS, CLARIFICATIONS, AND UPDATES

Europol is Not Part of Interpol

Sir: With regard to the March 2004 edition of *Microgram Bulletin*, and the item about 2C-I, your notes on page 48 referring to a related article in the May 2003 edition of the Europol *Drugs Intelligence Bulletin* are appreciated. However, please note that Europol is not "the drug arm of Interpol" as stated on page 49. In fact Europol is a totally separate entity - being the (single) law enforcement intelligence agency for the European Union. The Drugs Unit is a part of Europol which is mandated to deal with all areas of major organized crime. Europol co-operates with international organizations, including Interpol.

Additional Information on *N*–Methylpyrrolidinone - I

Sir: I have just received a copy of the March issue of *Microgram Bulletin* and read the Intelligence Alert regarding N-Methylpyrrolidinone (NMP). This compound was predicted to be a possible GHB analog in early 2001, and there is analytical information regarding it in the January 2001 issue of the CLIC Journal.

[Editor's Notes: The referenced article is: Morris JA. Analogs of GHB. Part 2: Analytical Perspective. Journal of the Clandestine Laboratory Investigating Chemists Association 2001;11(1):16. Note that the *Journal of the Clandestine Laboratory Investigating Chemists Association* is a law enforcement restricted publication.]

Additional Information on *N*–Methylpyrrolidinone - II

Sir: Some paint strippers contain a mixture of GBL and NMP as solvents. It would not be inconceivable that some entrepreneur attempted to make GHB from such a solvent, not realizing (or caring) about the presence or adverse effects of NMP. The net result would be a combination of GHB and NMP, as mentioned in the March *Microgram Bulletin*.

"Factory-Sealed" Cans May Not Be....

Sir: The January 2004 issue of *Microgram Bulletin* contained an Intelligence Alert on Page 6 referring to the smuggling of marijuana in "factory-sealed" cans. Our laboratory had an

TECHNICAL NOTE

Marsha M. Lee,[1] *Ph.D.*

The Identification of Cathinone in Khat (*Catha edulis*): A Time Study

REFERENCE: Lee, M. M., "The Identification of Cathinone in Khat (*Catha edulis*): A Time Study," *Journal of Forensic Sciences*, JFSCA, Vol. 40, No. 1, January 1995, pp. 116–121.

ABSTRACT: Previous studies on the khat plant (*Catha edulis*) illustrated the importance of using freshly harvested young shoots and leaves such that cathinone, the principal active component and Schedule I controlled drug contained within the plant, could be suitably isolated and identified. Upon drying and storage of the cut plant material, cathinone readily converts to the reduced product, cathine, which necessitates rapid extraction and chemical analysis for cathinone identification. This study demonstrates that by air drying the young khat shoots at ambient temperature, cathinone may be detected in khat samples that have been harvested for more than 10 days. Refrigeration for two weeks and freezing for one month of the khat samples also yield identifiable levels of cathinone. Cathinone and cathine are both specifically determined and differentiated by vapor phase infrared detection, which is the method of choice in relation to mass spectrometry.

KEYWORDS: forensic science, *Catha edulis*, khat, cathinone, cathine, controlled drug, vapor phase infrared detection

The chewing of khat, which typically consists of the young leaves and stems of the *Catha edulis* plant, for its stimulant effects has in the past been largely confined to its area of cultivation, namely, East Africa and the Arab Peninsula. Historically, cathine ((+)-norpseudoephedrine) (Fig. 1), was erroneously identified to be the active compound in khat which was responsible for the observed pharmacological effects because the investigations were based on dried or old plant samples. However, discrepancies in drug potency signaled to researchers that another compound was accountable for the effects. Using fresh young leaves or otherwise well-preserved khat samples, cathinone (2-amino-1-phenyl-1-propanone) (Fig. 2), was finally isolated and identified as the principal alkaloid [*1–8*]. Cathinone is estimated to be one-third as potent as amphetamine[2] and ten times more potent than cathine [*9*]. It has been found that during the maturation of the leaves or decomposition of the plant through drying and storage, cathinone contained within the plant is enzymatically converted to cathine [*5*].

Effective February 1993, cathinone was placed into Schedule I of the Controlled Substances Act [*10*]. Khat is a Schedule I substance when cathinone is present. Cathine is ruled as a Schedule IV substance [*11*]. When the plant no longer contains detectable levels of cathinone, as in older leaf samples, but contains cathine, khat is classified as a Schedule IV substance. This causes a logistical problem with cathinone detection since fresh khat leaves (or otherwise well-preserved sample) are needed for the analysis, in order for the sentence of a Schedule I drug to be invoked.

Fresh leaves are traditionally chewed as the cut khat loses its potency about 3 to 4 days after harvesting [*2*]. Despite the short period of drug effectiveness, the availability of rapid air freight service has resulted in the appearance of khat in non-origin countries, for example, United States, Italy, and Great Britain. Although it is now recognized that the rapid extraction and analysis of fresh khat samples is needed, the time frame required for cathinone detection has not yet been adequately addressed. Further, the focus of past khat studies relied upon using freshly picked khat samples, deep-freeze and freeze-dried preservation techniques, and temporary dry ice storage so that cathinone detection would be insured

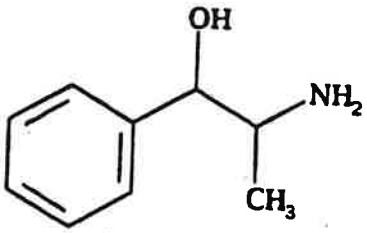

FIG. 1—*Cathine.*

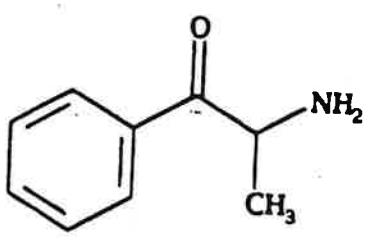

FIG. 2—*Cathinone.*

Received for publication 13 Jan. 1994; revised manuscript received 19 May 1994; accepted for publication 20 May 1994.

[1] Forensic Chemist, U.S. Drug Enforcement Administration, Western Laboratory, San Francisco, CA.

[2] Dr. Rudolf M. Brenneisen, Institute of Pharmacy, University of Berne, Berne, Switzerland, personal communication.

[2,7,9,12,13]. For law enforcement purposes, such specialized preservation techniques are not generally feasible or readily available at seizure sites. More practical means of sample storage and preservation were investigated in this study so that reasonable guidelines and expectations for cathinone detection in seized khat drug evidence could be made available. In addition to this, the use of vapor phase infrared detection (IRD) and mass spectrometry (MS) were evaluated for their specificity in cathinone and cathine identification.

Experimental Section

For this study, freshly picked khat shoots were sent from a domestically grown source to the Drug Enforcement Administration (DEA) Western Laboratory via express mail in a padded envelope, packed with shredded paper. The plant specimen was apportioned into smaller parcels. The bulk of the sample was left to air dry in a brown paper bag that was kept at ambient temperature and protected from light. Smaller sample portions were heat-sealed in evidence envelopes (that is, 0.0045-inch thick polyester barrier film) and placed in the laboratory refrigerator (−2°C) and freezer (−11°C). For the time study, a simple and rapid method to extract the compounds of interest was devised based on standard alkaloid extraction techniques [2]. The procedure is described as follows.

1. *Extraction*

Approximately 5 to 6 g of plant material was cut into small pieces, dimensions of approximately 0.5 cm squares. The prepared sample was mixed with 15–20 mL of methanol, then sonicated for 15 min with intermittent shaking and stirring.

2. *Concentration*

The green methanolic extract was decanted into a breaker [illegible] was then condensed to near dryness (<1 mL) using a stream [illegible]

3. *Cleanup*

A very dilute solution of H_2SO_4 (approx. 0.02 N) was [illegible] resuspend and acidify the plant residue. The acidified sol[illegible] acquired a reddish hue. A chloroform extraction was perfo[illegible] to remove the neutral organic compounds as well as the rem[illegible] plant solids.

4. *Base Extraction*

A small amount of a saturated sodium bicarbonate (Na[illegible] solution was added to the aqueous solution to basify the ex[illegible] The pH change resulted in a light green solution. Methylene c[illegible] ride was used to extract cathinone and cathine. A stream [illegible] was used to reduce the extract to a minimal volume amoun[illegible] a preventive measure, a solvent exchange to hexane is d[illegible] avoid degradation of the IRD light pipe.) Instrumental an[illegible] was performed immediately after the base extraction [8].

Vapor Phase Infrared Spectroscopy

The vapor phase infrared spectra were obtained on a Hew[illegible] Packard Model 5890 Series II Gas Chromatograph, using [illegible] by 0.32 mm HP-5 (0.52 μm loading) capillary column [illegible] temperature program of 70°C for 1 min, 15°/min to 270° [illegible] final temperature hold for 5 min, equipped with a Hewlett-P[illegible] Model 5965B Infrared Detector.

Mass Spectrometry

Mass spectra were obtained on a Hewlett-Packard Mode[illegible] Series II Gas Chromatograph, using a 12 m by 0.22 mm [illegible]

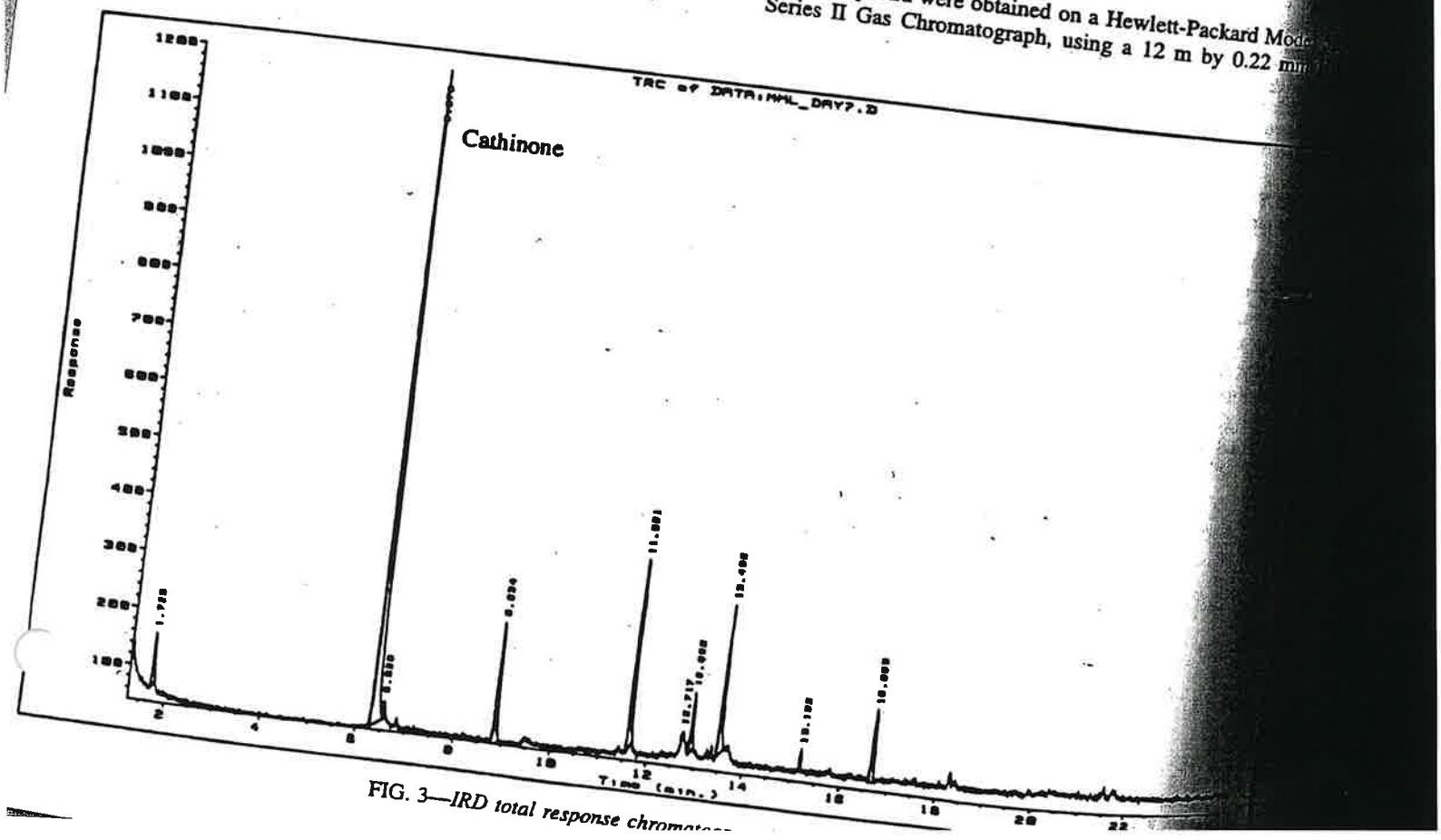

FIG. 3—*IRD total response chromato[illegible]*

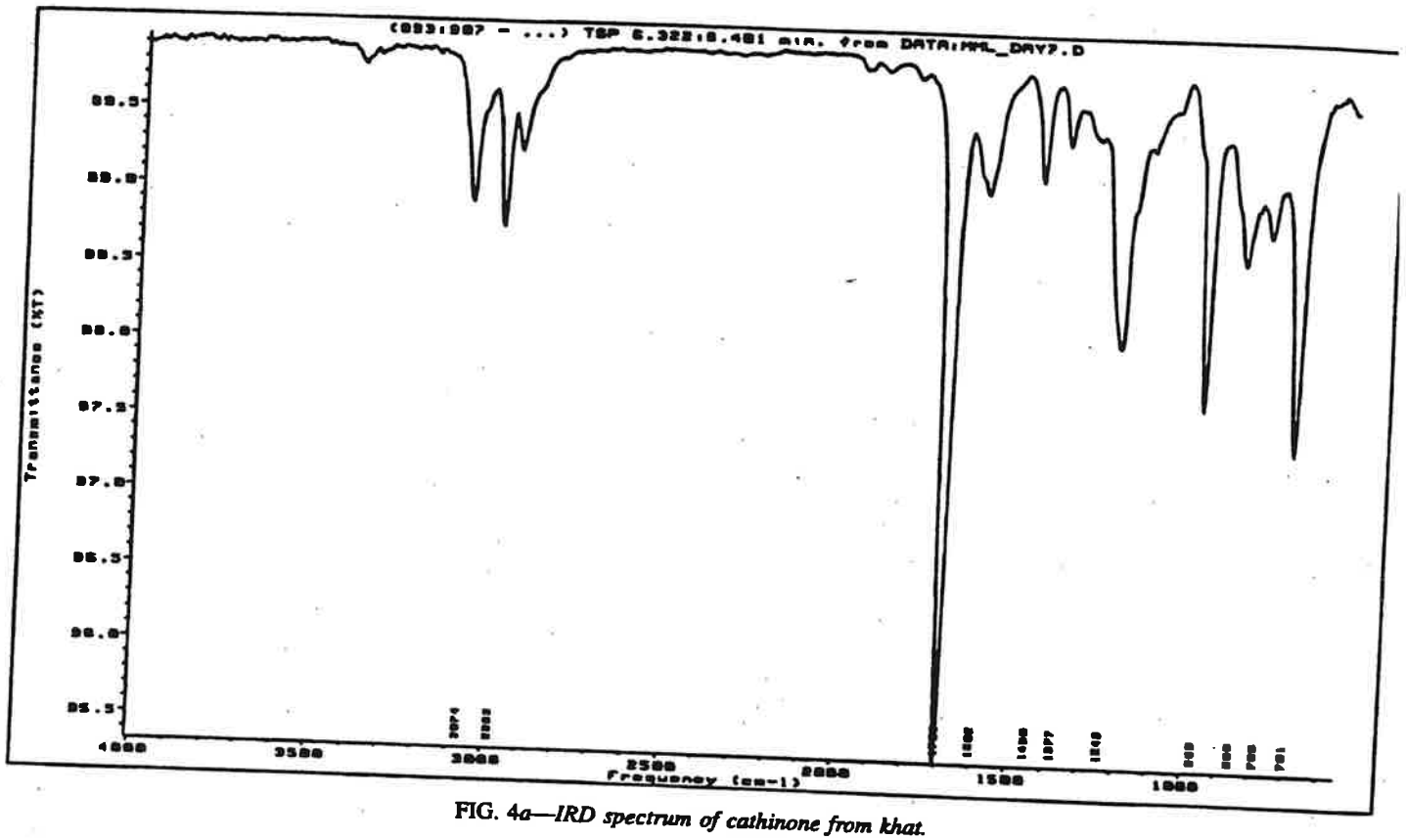

FIG. 4*a*—*IRD spectrum of cathinone from khat.*

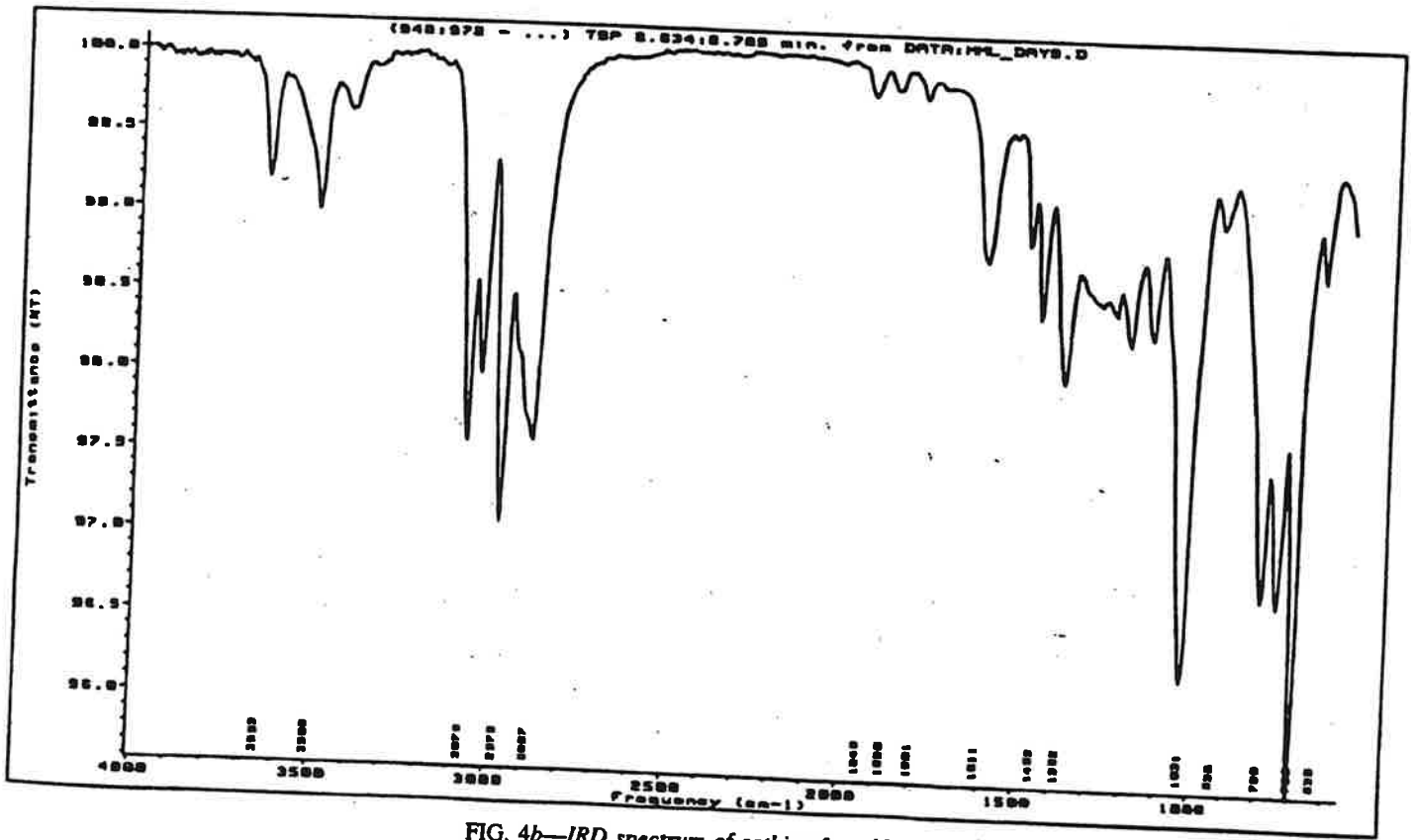

FIG. 4*b*—*IRD spectrum of cathine from khat.*

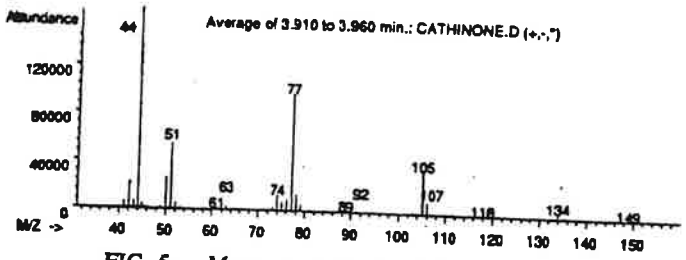

FIG. 5a—*Mass spectrum of cathinone standard.*

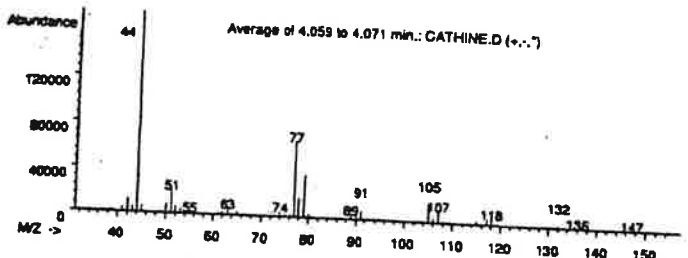

FIG. 5b—*Mass spectrum of cathine standard.*

(0.33 μm loading) capillary column and a temperature program of 100°C for 2 min, 15°/min to 300°, with a final temperature hold for 5 min, equipped with a Hewlett-Packard 5970 Mass Selective Detector (electron impact mode).

Thin-Layer Chromatography

The plant extract was spotted directly onto a precoated 5 by 10 cm silica gel 60 (Kieselgel F-254) plate. Cathinone and cathine drug standards (cathinone hydrochloride supplied by RSA Corporation, cathine base and cathine hydrochloride provided by DEA's Special Testing Laboratory) which were dissolved in methanol were also applied. The plate was developed in ethyl acetate: methanol: ammonia (85:10:5), then viewed under an ultraviolet lamp (254 nm) [2,7,8,12,14]. The spots were visualized using a 0.5% ninhydrin solution, and then the plate was heated using a heat gun. Cathine appeared purple, while cathinone was a burnt orange (faster moving spot). The R_f values obtained for cathinone and cathine were 0.46 and 0.25, respectively.

Results

Air-Dried Samples Stored at Room Temperature

Setting Day 1 as the day the khat material was harvested, 5 g of leaves and stems were removed from the paper bag on a daily basis and analyzed. Cathinone was detected as the major component in the Day 2 run of the IRD total response chromatogram (TRC), through Day 7 (Fig. 3). None or only a trace amount of cathine was detectable. On Day 5, cathine became detectable, in addition to cathinone. By Day 11, the cathinone IRD peak height in the TRC was twice or equivalent to the cathine peak, which made a positive identification for cathinone difficult, but still possible, due to the poor chromatographic separation. As the plant dried out, more leaves were needed to yield the 5 g sample size. Analyses for longer time periods were not performed since there was insufficient air-dried sample. The IRD detection of cathinone after 10 days of air drying is consistent with an earlier work which used thin-layer chromatography (TLC) to verify the presence of cathinone in collected khat samples that were first stored in thermoflasks containing dry ice for 3–4 days, then later allowed to air dry 7 to 10 days [12].

The IRD spectra for cathinone and cathine isolated from *Catha edulis* cuttings are shown in Figs. 4a,b and the mass spectra for cathinone and cathine standards are provided in Figs. 5a,b. Previous works have described using high-pressure liquid chromatography, gas chromatography, infrared spectroscopy, MS and TLC to identify cathinone and cathine. The mass spectra for the cathinone and cathine standards (Fig. 5a and 5b) are very similar, with an identical base peak at m/e 44 for both compounds. Some groups have used acetylation to better identify the two components.

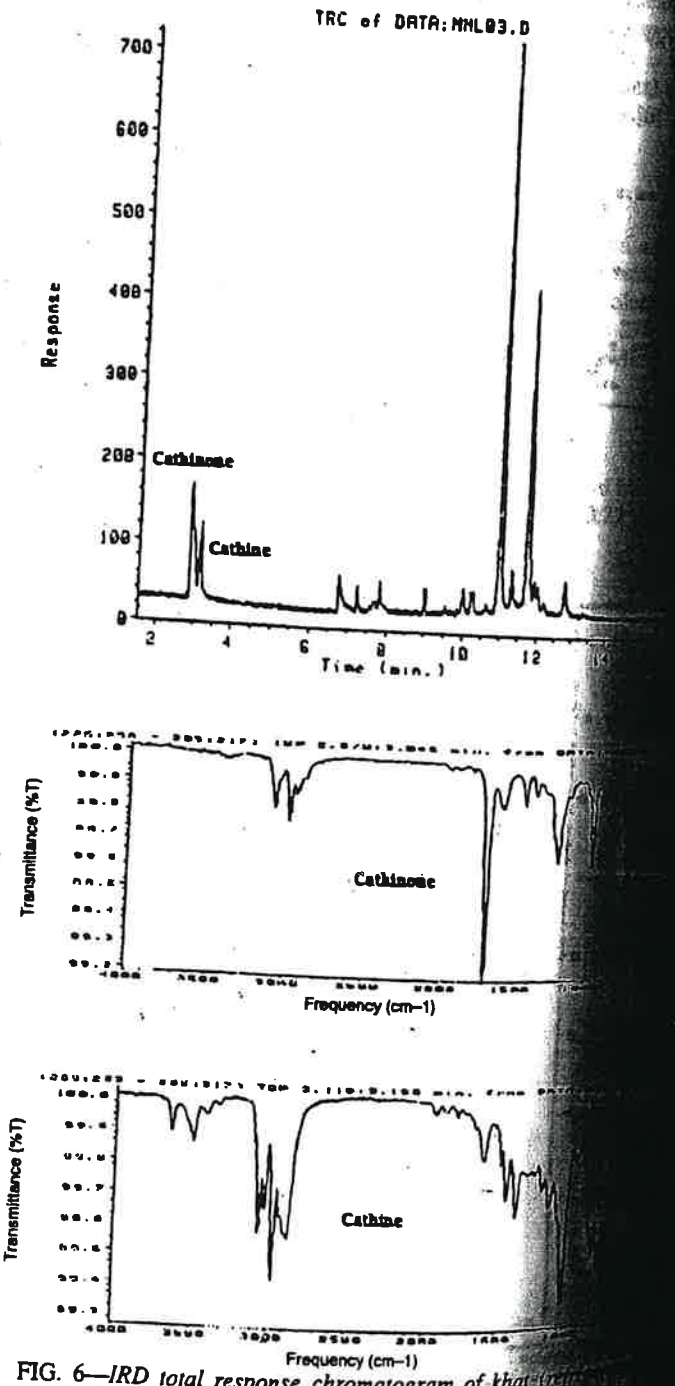

FIG. 6—*IRD total response chromatogram of khat (ref. 2 weeks).*

MS [8].[3] However, the IRD spectra for cathinone and cathine are unambiguous and unique (Fig. 4*a* and 4*b*).

Refrigerated Samples

A 3.5 g khat sample that was stored in a refrigerator for two weeks, exhibited cathinone and cathine (Fig. 6).

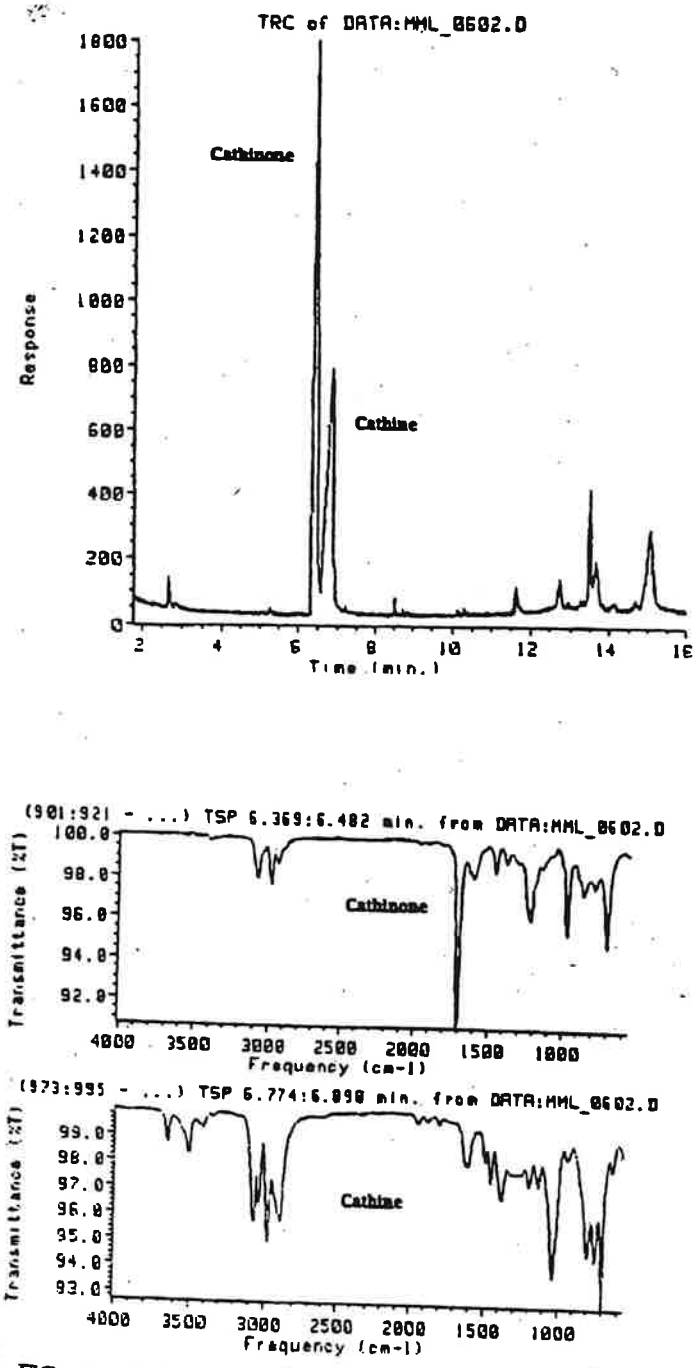

FIG. 7*a*—*IRD total response chromatogram of khat (frozen 34 days).*

[3]U.S. Drug Enforcement Administration, Northeast Laboratory, New York City, NY, personal communication.

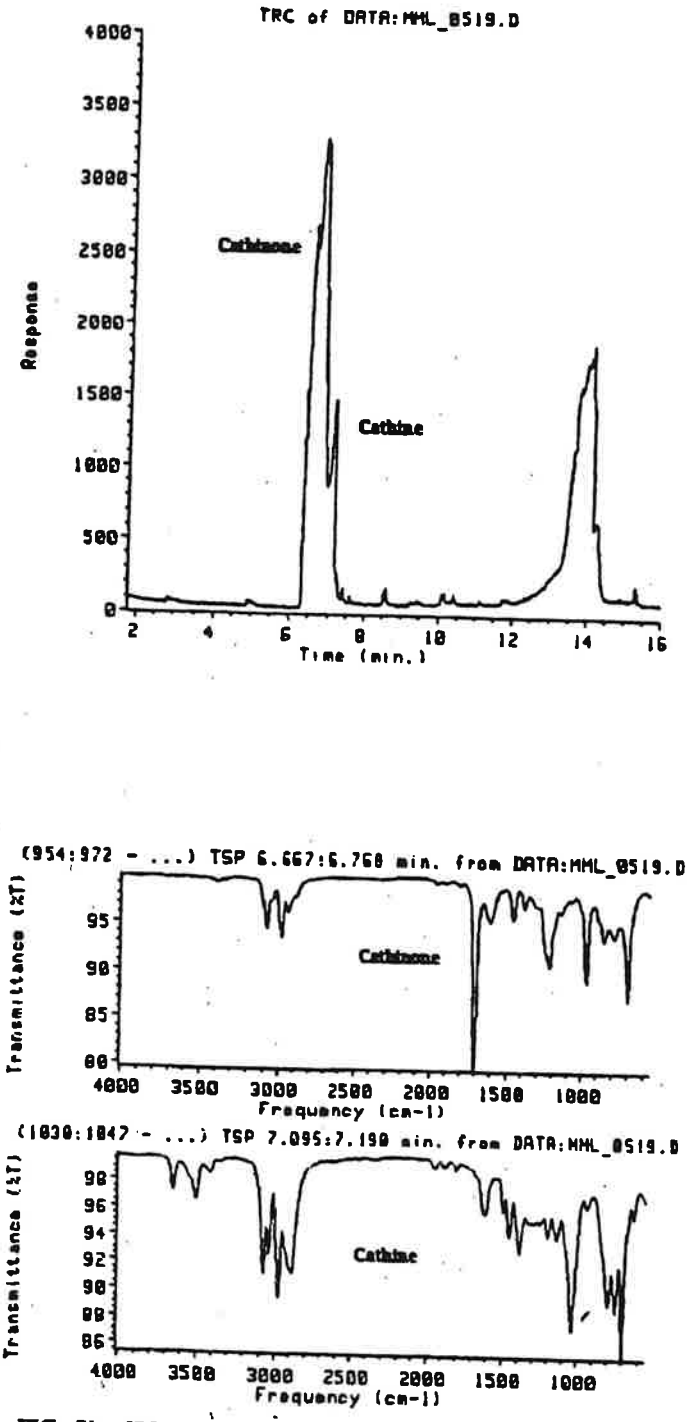

FIG. 7*b*—*IRD total response chromatogram of khat (frozen 48 days).*

Frozen Samples

Samples stored in the freezer for 34 days and 48 days both showed cathinone and cathine, with the cathine levels in higher concentration in the latter sample (Figs. 7*a,b*).

Actual Khat Exhibit

While this study was in progress, an actual khat exhibit was submitted to the Western Laboratory within four days of a U.S. Custom's

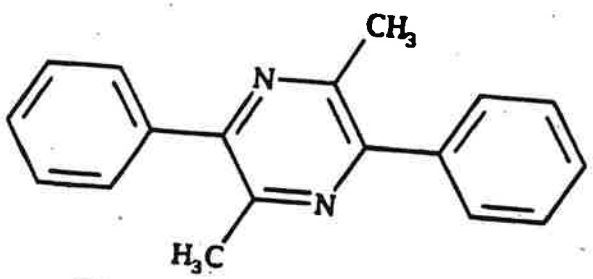

FIG. 8—*3.6-dimethyl-2.5-Diphenylpyrazine.*

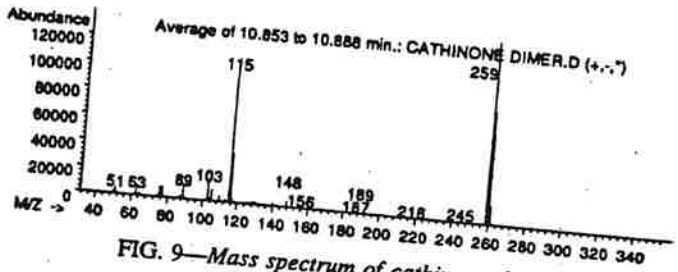

FIG. 9—*Mass spectrum of cathinone dimer.*

airport seizure. Although the sample was sent by overnight delivery and analyzed on the day of receipt, the exhibit had undergone significant spoilage as evidenced by a foul smell and a disproportionately large amount of wet, brown leaves. There have been a number of khat seizures submitted to several DEA field laboratories where the khat shoots were bundled and wrapped in large plant leaves.[2] In this particular case, the submitted plant exhibit was packaged in plastic bags rather than in leaves which severely restricted air flow around the plant cuttings. Although approx. 50% of the leaves still appeared to be in a fresh condition and were selectively used for the analysis, cathinone was fairly difficult to detect since its IRD peak height was only one-third that for cathine.

Recommendations for submitting khat samples to the laboratory now include: 1) sending a representative sampling of the exhibit in sealed paper bags, 2) packing the bags in sturdy cardboard boxes (which should then be properly sealed), 3) providing advance notice of the khat shipment to the laboratory, 4) sending the shipment by overnight delivery, and 5) storing the plant cuttings in a cool area until the analysis is conducted.

Additional Findings

Work by the DEA Northeast Laboratory has found that cathinone is concentrated in the leaves[3] rather than in the stems which is consistent with previous studies [*12,13*]. This present work supports earlier findings [*2,5,9*] that once the plant cuttings are harvested, the cathinone concentration within the plant gradually decreases with the concomitant formation of cathine. However, once cathinone is extracted from the khat leaves, the reduction process from cathinone to cathine ceases to occur. An undesired side reaction which develops during the cathinone isolation step is the oxidative dimerization of cathinone (3,6-dimethyl-2,5-diphenylpyrazine) [*2,7,8*], Figs. 8 and 9, which significantly decreases the amount of cathinone detected. Hence, rapid workup and analysis are recommended once the extraction process is completed to facilitate the detection of cathinone [*8*].

While the results presented in this study are based on several khat exhibits, it should be noted that cathinone levels in the plant can be highly variable; depending on factors such as species, plant maturity, origin, and quality [*9*].

Conclusions

This study provides conclusive results that cathinone can be extracted from harvested khat (*Catha edulis*) despite the elapse of almost two weeks to a month, when the plant samples do not visibly appear to be in their original freshly cut condition. Through proper sample handling, the sample holding time for khat plant material may be significantly extended while at the same time, allow for the due process of a Schedule I drug, cathinone, rather than the Schedule IV drug, cathine.

The use of vapor phase infrared spectroscopy to identify cathine and cathinone provides unambiguous and unequivocable spectra relative to that obtained by mass spectrometry.

Acknowledgments

The author gratefully appreciates the support for the study provided by Laboratory Director Howard Schlesinger, assistance of Department of Justice Special Agent Patty McCathron in supplying fresh khat samples, technical assistance provided by Forensic Chemist William Moriwaki, and helpful discussions with Senior Forensic Chemist Terry Dal Cason and Forensic Chemist Charles Cusumano.

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[*10*] "Schedules of Controlled Substances: Placement of Cathinone and 2,5-Dimethoxy-4-ethylamphetamine into Schedule I," *Federal Register,* Vol. 58, No. 9, January 14, 1993, pp. 4316–4318.

[*11*] "Schedules of Controlled Substances; Temporary Placement of Cathine ((+)-norpseudoephedrine), Fencamfamin, Fenproporex and Mazindenorex into Schedule IV," *Federal Register,* Vol. 53, No. 95, May 17, 1988, pp. 17459–17460.

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[*14*] Nordal, A. and Laane, M. M., "Identification of Khat," *Meddelelser fra Norsk Farmaceutisk Selskap,* Vol. 40, 1978, pp. 1–18.

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Drug Intelligence Brief

KHAT
JUNE 2002

Status in International Drug Trafficking

Although khat is illegal in the United States, it is legal throughout much of Europe, East Africa, and the Arabian Peninsula. Individuals of East African and Middle Eastern descent are most often responsible for the importation, distribution, possession, and use of khat in the United States.


A khat shrub

Background

Khat is a naturally occurring stimulant derived from the Catha edulis shrub. This shrub is primarily cultivated in East Africa and the Arabian Peninsula. The use of khat is an established cultural tradition for many social situations in those regions. Khat is also known as Abyssinian tea, African salad, oat, kat, chat, and catha. Khat has two active ingredients, cathinone and cathine.

- Cathinone is a Schedule I substance that produces a euphoric effect similar to amphetamine in that it stimulates the central nervous system. The cathinone in khat begins to degrade 48 hours after the plant has been cut. Khat that has been refrigerated or frozen will retain its cathinone potency for a longer period.

- Cathine is a Schedule IV substance that produces a much less intense stimulant effect than cathinone; however, it does not

Methcathinone

Methcathinone, commonly called cat, is occasionally confused with khat. Methcathinone is a synthetic Schedule I substance that has a similar chemical structure to the cathinone in the khat plant. Methcathinone is produced in clandestine laboratories and sold as a methamphetamine alternative. Ephedrine and/or pseudoephedrine are the main precursor chemicals used in methcathinone synthesis. The addictive properties and side effects of this synthetic are more intense than either of the naturally occurring khat substances.

lose its potency after harvesting.

Recent History

Several million people may currently be using khat worldwide; the largest concentrations of users are in the regions surrounding the Middle East. U.S. Customs Service (USCS) seizures of khat have risen from around 800 kilograms annually in 1992 to over 37.2 metric tons in 2001. The price of khat ranged from US$30 to US$60 per kilogram in 1992. Although current kilogram prices for khat are not available, the price of khat ranged from US$15 to US$50 per bundle in 1998. [Note: There is no method of converting bundles to kilograms, because the weights of the bundles vary—some bundles can weigh almost nothing while others can weigh much more. In addition, a bundle of khat can contain between 20 and 40 stems; the variance of weight and number of stems accounts for the wide range of prices per bundle. Seizures of khat, however, can be measured and are measured in kilograms.]

At a khat cultivation area

Cultivation

Khat is an important part of the economy of many producer countries, particularly Somalia and Yemen. Press reports from Yemen state that more than US$2 billion are spent annually by Yemenis to purchase khat, which is often grown on land that is unsuitable for other crops. [Note: Although khat is cultivated on land that is currently unsuitable for other crops, the cultivation of khat precludes the land's development for other purposes.]

Khat is grown in export quantities in countries such as Kenya and Ethiopia; it is Ethiopia's fourth largest export according to U.S. embassy reporting, and the recreational use of khat is widely accepted there. Over 33 percent of Yemen's gross national product is associated with the cultivation, consumption, and exportation of khat. The World Health Organization reports that the cultivation and use of khat has profound socioeconomic consequences on countries and individuals. The cultivation of khat requires scarce land and water resources that could be put to other uses. Khat use is costly and potentially addictive. Widespread frequent use of khat impacts productivity because it tends to reduce worker motivation.

The only known case of khat cultivation in the United States occurred in September 1998, when 1,076 khat plants were seized in a raid in Salinas, California. Sophisticated irrigation techniques were used in this outdoor-grow operation. The individual involved was of Middle Eastern origin; he earned approximately US$10,000 per month in khat sales.

Because the potency of the cathinone in the khat is reduced as the plant material dries,

shipment by air is the most common method of transport.

Trafficking

Khat is usually shipped already packaged into bundles, and wrapped in plastic bags or banana leaves to retain moisture and freshness. Khat is generally smuggled in passenger luggage, overnight express mail (USPS, UPS, DHL, etc.), or shipped as air cargo and falsely labeled as "vegetables." According to the U.S. Food and Drug Administration, khat is sometimes falsely labeled and shipped to the United States as molokheya, an Egyptian vegetable.

Most khat seized in the United States has been seized from immigrants of Somalia, Ethiopia, Yemen, Eritrea, and other countries where khat use is common. The USCS makes most of its khat seizures at the JFK International Airport in New York from arriving passengers, overnight express mail, and air cargo. Of the over 27 metric tons seized by the USCS in FY 1998, almost 18 metric tons were seized from flights arriving from Great Britain. Most cases of khat trafficking in the United States are prosecuted at the state level rather than in the federal court system.

Use/Abuse of Khat


Two men chewing khat

Khat has been used since antiquity as a recreational and religious drug by natives of Eastern Africa, the Arabian Peninsula, and the Middle East. Khat is legal in many countries, including Great Britain where khat can be legally imported, distributed, used, and/or exported. Khat has long been an acceptable substitute for alcohol among Muslims. During the period of Ramadan, the use of khat is popular to alleviate fatigue and reduce hunger. Although khat can be abused, it is often used in a social context similar to the manner in which coffee is consumed in other parts of the world. Reports from Yemen indicate that khat is consumed by 3 out of every 4 Yemenis, and accounts for more than 40 percent of the average family budget.

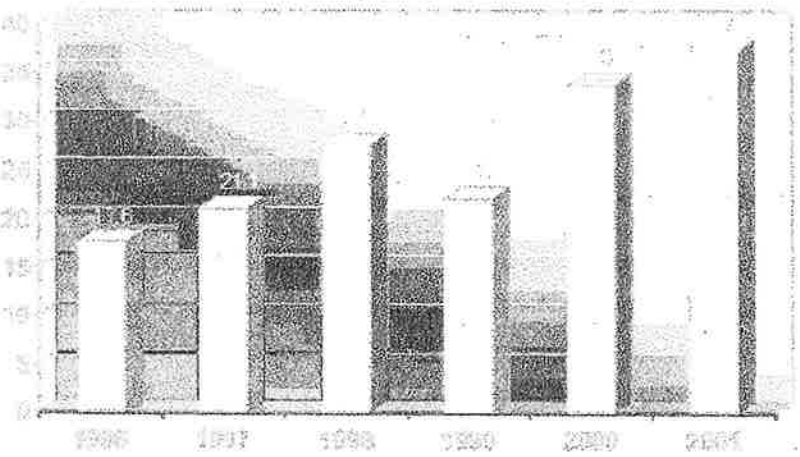
Khat is typically chewed like tobacco. The fresh leaves, twigs, and shoots of the khat shrub are chewed, and then retained in the cheek and chewed intermittently to release the active drug. Dried plant material can be made into tea or a chewable paste, but dried khat is not as potent as the fresh plant product. Khat can also be smoked and even sprinkled on food.

Chronic khat abuse can result in symptoms such as physical exhaustion, violence, and suicidal depression, which are similar to amphetamine addiction. Common side effects include anorexia, tachycardia, hypertension, insomnia, and gastric disorders.

Statistics

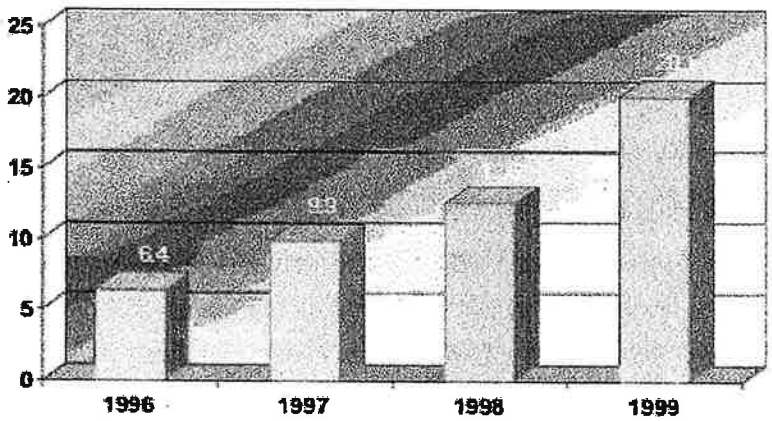
Seizures of Khat at U.S. Ports of Entry
Metric Tons

SOURCE: El Paso Intelligence Center (EPIC) from USCS data



Seizures of Khat (Non-U.S.)
Metric Tons

SOURCE: Interpol Statistics for the years 2000 and 2001 are unavailable.



Key Judgments

The amount of khat seized in the United States has been steadily increasing; it appears to be related to the increasing number of immigrants from Somalia, Ethiopia, Yemen, Eritrea, and other countries where khat use is common. Although it is hard to predict future immigration trends, it seems likely that the importation of khat will continue to increase to meet the demand of those ethnic groups who are accustomed to using it.

It does not seem likely at this point that khat use will expand beyond the ethnic Somalian, Ethiopian, Yemeni, and Eritrean communities. There is no indication that khat is marketed outside these ethnic communities although it appears to be readily available.

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K-4

Khat

Khat is a shrub the leaves of which are used as a stimulant or a medicine in certain regions of East Africa and Arabia. The question of khat has been placed by the Narcotics Commission on the provisional agenda of its twelfth session, scheduled to meet in April 1957, on the proposal of the representative of Egypt. The following article is a compilation of information from existing published sources on the subject, which are of varying degrees of authority; and it should be regarded as of a background character, pending closer examination of the question by the Commission.

Historical Background

Khat was probably known and used on the Ethiopian uplands, where it seems that it originated, in very ancient times. It is, however, impossible to fix accurately its original habitat and the region where it first developed. As is usual in such cases, some authors state that it was not unknown to classical antiquity. Merab, for instance (58), thinks that it was the smoke of khat that inspired the Delphic pythoness, that Homer's *nepenthe* offered by Helen to Telemachus was none other than khat and that Alexander the Great used it to cure his army of an epidemic disease. There are equally unverifiable suggestions with regard to cannabis and opium, and no importance can be attached to such suppositions.

The first historical reference, as far as could be determined from the literature consulted, occurs in a medieval Arab manuscript (MS.143, Bibliothèque nationale, Paris), where it is stated that the King of Ifat, Sabr Ad-Din decided to plant khat in the town of Marad (the period in question seems to be the first half of the fourteenth century). According to Rochet d'Héricourt (75), khat was introduced from Ethiopia into the Yemen in 1424 by Sheikh Abu Zerbin. Another reference to its cultivation in the fourteenth century in the region of Aden and in the Yemen is found in a sixteenth-century Arab chronicler, Abdul-Kadir. Its cultivation in that region is thought to be earlier than that of coffee (82). Khat was not known to the scientific world until the end of the eighteenth century. During an expedition organized by King Frederick V of Denmark, the physician and botanist Peter Forsskal collected, among many other plants, specimens of khat, which he described under the name of *Catha edulis*. The only survivor of the five members of the expedition, the Hanoverian geographer, Karsten Niebuhr, published the botanical papers in 1775, and in memory of his friend called *Catha edulis* " *Catha edulis forssk* " (65).

In the first half of the nineteenth century, various travellers and scientists visiting Arabia and East and South East Africa referred to and described khat either under that name or variants of it : *Celastrus edulis* Vahl, by Ferret and Galinier (37), *Catha Forsskali A. Richard*, by R. Petit, *Methyscophyllum glaucum*, by Ecklen and Zeyher (27), etc.

Description

Khat is a shrub with persistent leaves of the *Celastraceae* family, relatively of little importance, which includes the spindle-tree, *Celastrus*, etc.; mention may be made, however, of a Philippines plant of the same family, *Lophopetalum toxicum*, containing a poisonous substance lophopetalin, which is used in the composition of arrow-head poisons (67). Khat grows to between 3 ft and 6 ft (1–2 m) in high and dry soils, reaches 20 ft (6 m) on the moist slopes of the Ethiopian mountains and may even in the equatorial region under favourable circumstances reach a height of 80 ft (25 m). The trunk may be some 24 in (60 cm) in circumference and the bark is thin, smooth and brown; in appearance the tree is not unlike the tea shrub.

The new *leaves* are reddish-brown, becoming greenish-yellow when fully grown. They are bifarious, elliptical, lanceolate, sharp, coriaceous and almost tasteless. Dimensions vary widely from 0.2 in (0.5 cm) to almost 3 in (7 cm). The limb, which at the base is smooth, has over the remainder of the leaf short, mossy serrations; the median vein projects on the under, reddish side; the secondary veins meet before the margin of the limb; between the secondary veins the smaller ones form a reticulate venation. From the histological point of view, Perrot (67) gives the following description : " Glabrous epidermis; bi-facial messophyl with two palisade layers and spongy parenchyma with ramous cells of twin crystals, isolated or sometimes grouped in clusters in the same cell. Fasciculate system in an arc almost closed by two superior phlöem-lignous strands. Many periphlöem units. Crystalliginous phlöem ".

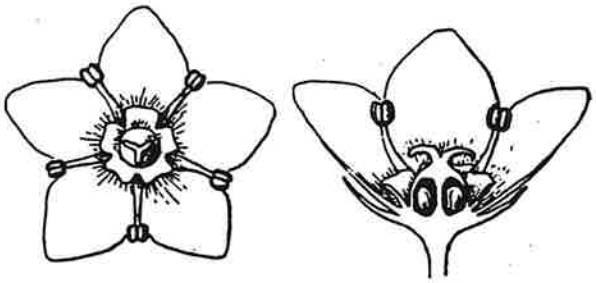

FIGURE 1

Flower of khat

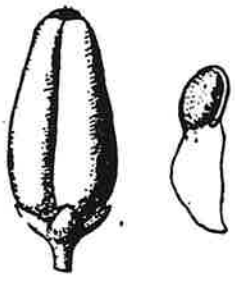

FIGURE 2

Fruit and seed of khat (note the " wing " of the seed)

The *flowers* are small, white or greenish and arranged in axillary cymes. They have five equal sepals, deeply indented, and five oblong petals. The *fruit* is a linear capsule, dark brown, with three valves, each *loculus* containing one to three small *seeds* at the base of a thin brown wing. The seeds, brown-red in colour are about one-eighth of an inch (3 mm) long.

Variants and Vernacular Names

It is generally recognized that the genus *Catha edulis* consists of only one species; however, in view of its extreme polymorphism, it is certain that it comprises several cultural varieties which seem not to have the same properties. A. Chevalier (20) points out that A. Richard noted in Ethiopia a variety which he calls *Celastrus padinus Rich.* with longer petioles and broader limbs. The Natal form, called *Methyscophyllum glaucum* Eckl. and Zeyher is certainly a distinct variety with narrow glaucous leaves; it is called *Catha glauca comb. nov.*

Given this polymorphism and also the many races represented by those who use khat, the plant is known by a wide range of names which designate either the whole shrub or a quality of the product utilized. The Arab name of khat is the commonest—mainly because Arabic is by far the most widely used language of those which refer to the shrub or its parts. This is the term used in Europe, with variants which are simply phonetic transcriptions according to the language (catha, khat, kat, qat, ciat, etc.). Khat is the name designating the whole plant in Somali and in Amharic, (variant : tschat). The name which is, practically speaking, the most important after khat is " mira " or " miraa "—found in Masai, Kikuyu, Tukuyu and frequently in official or scientific texts in South and East Africa.

In view of the confused state of the literature of the subject in this respect, a list of terms used in East Africa to indicate the plant khat is given below (according to Greenway (40)) :

Gazaland

Mutsawhari (Chendao).

Kenya

Kat (Somali); mirungi, muirungi and miraa (Kikuyu); ol meraa (Masai); liss (Mar.); tumayot (Dor.); muraa (Mer.); mairongi (Mt. Kenya); meongi, maonj and miungi (Kamb.).

Nyasaland

Mutsawari (Mlanje); mdimamadzi (Dedza).

Uganda

Musitate (Lumwege).

Tanganyika

Mlonge (Swahili); mulungi (Somali); warfo, warfi and waifo (Mbulu); seri (Fiome); mandoma, mwandama, m'mke and mfeike (Shambaa); mzengo (Nguru); msekera (Kilongo, Uzinza); nangungwe (Mwera); mhulu, muhulu and muhulo (Hehe); liruti (Hehe, Fuagi); msabukinga (Kinga); msuruti, msuvuti and mbungula mabwe (Rungwe); mira and mbungula mabwe (Tukuyu); ikwa (Nyika).

On the other hand, some authors (20, 39, 68, 83) give lists of terms which distinguish the various qualities of khat. The definitions do not always exactly agree and the chief conclusion to be drawn is that in whatever region it is consumed, khat is regarded as are tea and coffee by connoisseurs, the criteria being the part of the plant utilized (leaves, buds, twigs or a mixture of two or all of these forms), the degree of maturity and, consequently, of size (the young shoots and the small red leaves are the most appreciated), and lastly the region of origin. It seems that there are " vintage " khats and, in all probability, the fraud and the snobbery that accompany that idea. Obviously the choice will depend on the use to be made of khat (see below) and also on the price, which varies considerably with the quality of the product.

Chemical and Pharmacological Aspects

The above-mentioned differences are empirical and subjective in character, and no thorough scientific investigation has been made of them because the authors working on khat never had at their disposal the complete collections of samples of leaves, etc., which would allow the establishment of valid conclusions. From the point of view of the effect, it is quite clear that there is little connexion between the small, thin leaf of a bush some 3 ft (1 m) high, growing at 5,000 ft (1,500 m) in an arid soil, and that of a 16-foot (5 m) tree growing in the equatorial zone. In fact, experience in the case of other alkaloid plants shows that the effects vary with the soil and climatic conditions in which the plant grows (and obviously of cultivation, if the plant is cultivated), that

FIGURE 3

Flowering khat twig (from Nyasaland). Note the large size of the leaves

FIGURE 4

Khat twig with fruit (from Cape Province). The leaves are small and elongated

the alkaloid content changes and that under certain conditions some effects may disappear entirely (for instance, the variations in the opium alkaloids). Further practical proof as regards khat is provided by Mustard (62), who reports the introduction of khat into Florida, where it has been successfully cultivated, and where leaves eaten experimentally had no effect on those who chewed them.

It is therefore impossible at this stage to draw up an overall scientific table of the properties of khat. That is why the following approach has been chosen : first, to give a description of what is known of the chemical analysis of the plant and of the effects of its alkaloids, and to deal in a later chapter with the effects in practice upon man of the plant as cultivated.

* * *

The first studies were those of Flückiger & Gerock (86) and of Paul (86) & Mosso (63). The first two isolated an alkaloid that they called cathine, the last an alkaloid to which he gave the name celastrine. In fact, these studies were of little use, for the substances discovered were quite impure. The second stage of research was in 1901 when Beitter (8) claimed to have extracted a certain number of salts of cathine (sulphate, hydrochloride, hydrobromide, salicylate) and described cathine as crystallizing into needle crystals, bitter in taste, with no smell, soluble in ether, alcohol and chloroform. The formula he gave was $C_{10}H_{18}NO_2$. Subsequently, J. Chevalier studied khat and published an important work in 1911 (21). He suggested the possible utilization of khat or cathine in the withdrawal cure from morphine, a suggestion which does not seem to have been followed up.

In 1912 the *Pharmaceutical Journal and Pharmacist* published a communication made to the Pharmaceutical Society by Dr. R. Stockman (79). This important article gives details of his discovery of three alkaloids of khat : cathine, cathidine and cathinine. The author had at his disposal dried leaves, but—because of either experimental obstacles or difficulties inherent in the substances—he obtained only a low and variable yield. In addition to the alkaloids, the leaves contained sugar, tannin, a small quantity of rubber, a wax-like substance, and a small quantity of a yellowish essential oil that was pleasant to smell and to taste. The first alkaloid isolated, cathine—as a sulphate—was in the form of white, needle crystals, of bitter taste, easily soluble in water and diluted alcohol, but not in pure alcohol, chloroform, ether, etc.

Cathidine is a white amorphous powder insoluble in water, soluble in ether, pure alcohol, acetone, etc.

These descriptions were repeated more or less exactly in subsequent publications (up to and including the Merck Index 1940) (59). The proportions given for the three alkaloids (which, as has been seen, must be taken with reserve) are 0.27 per cent for cathine, 0.32 per cent for cathidine and 0.15 per cent for cathinine. Even admitting possibilities of wide error, these percentages are such that commercial extraction does not seem very promising.

In 1930, Wolfes (86) gave for cathine a different formula from that of Beitter (perhaps the latter had isolated the substance in the form of glycoside) : $C_9H_{13}NO_2$. He showed that it is identical with d-nor-iso-ephedrine $C_6H_5CHOH.CH(NH_2)CH_3$. This substance is one of the alkaloids which in the *Ephedra vulgaris* of Japan (Ma-Huang) are the satellites of the *l*-ephedrine used commonly in medicine as a sympathetic comimetic. Possibly, according to Hesse's theory (46), the other two alkaloids also closely resemble ephedrine.

On account of the difficulties of obtaining leaves of khat, whether fresh or not, and perhaps also because of their small commercial value as shown by the early analysis, original studies on the chemical composition of khat are rare. In 1952, Miss Mustard (62) published the results of research into tropical plants in order to determine their ascorbic acid content. She made five analyses of a mixture of leaves and twigs—" commercial khat "—and found an ascorbic acid content of 135.7 mg/100 g. Analysis of leaves only gave the high content of 324 mg/100 g. Obviously, it might be stated that the khat consumers use it unconsciously on account of the high ascorbic acid content, but even if that were relevant to the consumption of khat, it is probably only one, and not the most important, among many considerations (it is true that scurvy is endemo-sporadic in the region where khat is consumed, but there are in such regions many other plants containing ascorbic acid that are not chewed).

Lastly, Peters (68) draws attention to a very interesting fact : " In a recent series of analyses (1952) carried out by the government laboratories, London, it was demonstrated that there was no appreciable difference between the alkaloidal properties of fresh samples of khat and samples that had been dried and preserved for a period of ten days. It would appear from this that, if indeed there is a difference between the properties of the fresh leaves and those of the dry—and local opinion substantiates this—there is an additional factor to be considered, which might well be a property contained in the resin of the plant."

Methods of consuming Khat

Methods of consuming khat vary according to a certain number of factors : the regions concerned, and of course, the kind of khat that the consumer has available, the price he can pay and, lastly, the purpose of using it—that is to say, his own personal tastes. Fifty years ago the methods were relatively the same for all the regions, since transport, being by caravan, was slow, and, consequently, khat was necessarily consumed dry by those who did not cultivate it. The methods have changed since transport is now either by rail or, particularly, by air. Whereas nineteenth-century travellers and explorers nearly always described the Arabian use as being in the form of infusions of the dried leaf, nowadays this method seems to be giving way to mastication of the fresh leaf, since khat is imported to Aden and the Yemen and elsewhere by air from Harar. This shows that the methods of consuming khat were not necessarily the result of choice or particular taste, but depended rather on circumstances.

The three normal methods of consuming khat are : (1) *chewing*—in this case the fresh plant is used—i.e., khat picked four or five days previously (at most), which has kept its moisture, since for that purpose it has been wrapped in leaves which are moistened from time to time. The more tender and juicy the leaves (either because they are taken from a plant variety with small leaves or because they are picked from the end of a branch), the easier it is to chew them and consequently the more they are appreciated. Thus, according to Peters (66), there is in Amharic a special name for this kind of leaf (koda) and also in Somali (hagafa). According to Vaughan (83), this kind of khat, called malhani, is more sought after in Southern Arabia, Aden, the Yemen, Hadramaut, etc. According to the size and the freshness of the leaves, therefore, there are " vintages " of khat, which are highly appreciated by the connoisseurs, and the price of which varies with the demand. A consumer used to good-quality khat chewed fresh would find it as difficult to get used to the dried leaves as, for instance, a cigar-smoker would to chewing tobacco. When the khat to which the consumer is accustomed is unobtainable, he would rather go without than try an inferior quality.

To chew the khat, the twigs are stripped of their leaves, which are made into a kind of quid, which is chewed until all the juice is extracted. To help the process, the chewer drinks large quantities of water. The process may last ten minutes or a quarter of an hour; when it is over, the residue is swallowed. During chewing, cigarettes are sometimes smoked. It may be remarked that when the leaf is fresh, the saliva is sufficient to extract the active elements—the alkaloids alone or combined with some other part—whereas with the dried leaves chewing alone does not seem to be sufficient.

The second method consists in using the large leaves which would be too hard for chewing or the leaves that have lost their freshness on too long a journey. In this case, the leaves are used dry—either the large leaves after drying in the sun or the others used as received from the seller. The dried leaves are powdered in a mortar; the powder is placed in a bowl and, after adding sugar and sometimes spices and water, a kind of paste is made, which is then chewed. As before, the residue is swallowed—and large quantities of water are drunk—probably to facilitate the extraction of the active elements. It may be added that, according to individual taste or to regions—always where fresh leaves are not available—a khat infusion is made in the same way as tea. This method is not very common and is followed mainly in South Africa (64). It is more usual to add to ordinary tea fragments of khat twigs to alter the taste and the effect of the tea. It may be pointed out that with infusion, at least one of the alkaloids, cathidine, is lost, being insoluble in water, for so far as is known the residue of the infusion is not consumed. Since it seems that the effect is not different from that produced by chewing, it may be concluded that cathidine is not responsible for the effect produced by khat, although the action of khat is still not very well known. Merab (58) points out that the Ethiopian Christians use khat in preparing certain of their beverages (tedgee and talla).

Lastly, in certain parts of Arabia, khat is smoked like tobacco or cannabis, the ends of the twigs and the leaves being first crushed and then rolled in cigarettes (no mention of khat smoked in a narghile has been found).

The taste for the different varieties of khat seems as strange to those who are not accustomed to it as the choice between different qualities of wine or tea to non-initiates : it has probably not much to do with the alkaloid content. Khat is taken not only for its stimulating or inebriating effect, but also for the pleasure given at the time of taking it. From that point of view, therefore, it must be ranked with substances such as tea, tobacco, alcohol, etc., at any rate as regards occasional use. According to observations made on the spot it appears that after some time, once the need has been created, khat is no longer used for the pleasure derived from its taste, but mainly or solely for its effect; that marks the transition between the occasional and the habitual user. It may be observed that it is about the same with alcohol, which is taken by the occasional consumer for the pleasure derived from it, whereas the confirmed drunkard seeks principally or solely for the effect, whatever the taste or the appearance of the product consumed. In this connexion, some authors have wondered whether the real difference between occasional consumption, which might be styled pleasure or " sociability " consumption, and harmful habits does not lie precisely in the fact that the pleasure, which is sought at the time of consumption, is complex in nature—taste plus knowledge of the effect—whereas in the case of a harmful habit there is mainly or exclusively the craving for the effect.

Before considering the effects of khat, it may be remarked that it is consumed—when it is consumed for pleasure—in a group; that is to say it is a part of social life. In almost all the regions of habitual use, travellers mention this social habit—for instance, the fact of offering the stranger or the guest a twig of khat to chew or to welcome him in offering him a cup of khat, just as elsewhere he would be given a cup of coffee or a cocktail. Moreover, khat is very frequently taken socially, either in shops or public places where men meet to pass the time of day, or in private houses, where one is invited to " take khat ". Here again, as with alcohol and the like, there is a marked difference between the occasional consumer, who uses it in company, and the inveterate consumer who looks for the effect, and for whom in consequence the social aspect is a drawback rather than an advantage.

Effects of Khat

The foregoing analyses show that the effects of khat are quite different on the occasional and on the habitual consumer. On the former they will be strictly proportionate to the quantity of khat taken. The case of the latter is much more

complex. First, the effects obviously include the consequences of the khat taken as such—and the habitual user consumes increasingly large quantities in order to obtain the same effect; then there is a whole series of secondary *physiological* effects. The inveterate consumer loses his appetite and eats less and less; his body becomes emaciated, and he falls a victim to various deficiency diseases, not to mention secondary complications, such as constipation, etc. Among the *psychological* effects, the person who sleeps and eats less falls a victim to various illnesses. He clearly loses intellectual and will power. That situation gives rise to certain *social consequences*. The inveterate consumer no longer bothers about himself, his family or the rest of society. If he has the means for procuring khat, he becomes a mere human wreck. If he has not got the necessary money, he turns to begging or some kind of anti-social activity, such as crime.

Little is known of the effect of khat on a normal individual without considering the period of use. Since it has not been thoroughly studied from the scientific point of view, but only empirically observed by travellers or, less frequently, reported by those who have taken it occasionally, the descriptions of it are sometimes contradictory. Generally speaking, there is a kind of exaltation, beginning with a feeling of being liberated from space and time, accompanied by extreme loquacity and inane laughter, until a semi-coma intervenes, out of which the consumer awakes in a painful condition. In the first stage, therefore, there is intellectual excitation with euphoria, in the second stage the numbing of the intellectual faculties, and in the third the eclipse of these faculties —lack of attention and memory accompanied by the liberation of violent instincts.

A distinction must be made between occasional and chronic use :

In the case of *occasional use* khat abolishes sensations of fatigue and hunger, soothes passions such as anger, then degenerates into a state of veritable poisoning, accompanied by dilatation of the pupil, cold sweats, convulsions, hyperaesthesia, etc. and, if taken in excessive quantities, may even result in death. (Heisch (44) describes a specific case that he had observed of a khat-chewer who, when taken to hospital, showed the above-mentioned symptoms, then passed into a coma and died after four days. At the post-mortem, the stomach was discovered to be full of khat and death could not be attributed to any other cause than its consumption.)

In the case of *chronic use*, khat numbs the intellectual faculties and leads to complete stupor or madness. Carrothers (17) reports two cases of madness brought on by khat in which he observed incoherence, feverish excitation, marked troubles with a schizophrenic character and, finally, manifestations akin to *delirium tremens*. Incidentally, both patients quickly returned to normal when the khat was withdrawn.

To sum it, there is a quasi-medical use of khat : it has been used for a long time by couriers carrying urgent messages as sustenance during the journey when there was no time to stop for eating or sleeping. It is also used in traditional medicine in Ethiopia, Arabia and elsewhere for all sorts of purposes—e.g., as a diuretic in the treatment of gonorrhoea—as a prophylactic against malaria, asthma, coughing and diseases of the chest, stomach trouble and even as a preventive against plague. This list shows that in the therapeutic practice of primitive traditional medicine khat becomes a panacea.

Khat has also a *religious or magic* significance. According to Tanret, (80) Mgr. Jarosseau, Bishop of Harar, noted this phenomenon in the following terms : " The whole country is persuaded that this shrub enjoys divine blessing; no private or public religious ceremony can take place without the ritual chewing of the leaf accompanied by much praying and singing. In the Moslems of Harar it induces a strong religious exaltation, which they regard as a gift from heaven."

There is again the use of khat for pleasure. Since khat is regarded as an excitant and a stimulant like coffee, tea and the like, it is generally not considered prohibited by Koranic law and consequently there is no moral objection in the Moslem countries affected against its abuse.

Khat is used in relatively poor regions, where the frequent lack of food encourages deficiency diseases. Consequently, in view of its stimulating effect, it is often not unnaturally regarded as a divine blessing.

For populations with relatively few sources of distraction it constitutes a simple and convenient form of escapism.

The observations, however superficial, that have been made show that khat may produce a definite intellectual and moral deterioration and that its social consequences may be serious.

Except in sporadic cases such as the utilization of the wood of the shrub, it is generally not used for industrial purposes.

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Khat: pharmacognostical aspects

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ABSTRACT

A survey was made of the early literature on the production of khat. A botanical and micromorphological examination of 15 samples of *Catha edulis* was carried out and the findings were compared with data from the earlier literature on the subject. Based on earlier and present observations, the vital organs (leaves, flowers, fruit and seeds) are described, with illustrations, to assist in the identification of khat.

Introduction

Khat is usually described as the young fresh shoots and leaves of *Catha edulis* Forsk., a species of the plant family Celastraceae. It is also known by various other names, such as chat, gat, Kus-es-Salahin, miraa, tohai and tschat. The dried leaves are known as Abyssinian or Arabian tea [1].

Catha edulis is a shrub or small tree that has been cultivated for centuries. Its original habitat seems to have been the region of Ethiopia, whence it was brought to neighbouring regions. There are records of the use of khat in southern Arabia in the fifteenth century [2]. At the present time, *Catha edulis* grows in the southern part of Arabia and in Africa, where its habitat extends from northern Ethiopia and part of the Sudan as far south as South Africa [3].

Even if most botanists agree that there is only one species of the genus *Catha,* there may be considerable variations in the general appearance of samples of khat from different regions. There is reason to believe that these variations are due to the cultivation of the plant over the centuries under differing ecological conditions, as well as to local traditions connected with cultivation and harvesting.

Production

In 1900, on the basis of reports by earlier authors, Beitter [4] described the cultivation, harvesting and marketing of khat, which was recorded as growing in north-east Africa and south-west Arabia between latitudes 18° N and 30° S.

The main areas of cultivation were in Ethiopia, particularly in the Harar district, and in Yemen, where it was grown south of Sana'a in the valleys of Upas and Aphis, as well as on the plateaus at altitudes of over 600 m above sea level. Important sites were Djebel Saber and Djebel Reima, where khat was cultivated on terraces, sometimes in conjunction with coffee plantations.

Quoting the observations of P. E. Botta, who travelled in the area in 1837, Beitter reports that khat was cultivated in Yemen from cuttings that were allowed to develop for three years. The shrubs thus produced were then stripped of their leaves, with the exception of those from some side branches, which developed into young shoots in the fourth year. Cut and bundled, these were sold as *kat moubarreh,* considered to be of inferior quality. The following year, new shoots grew on the branches that had been stripped and these were sold as *kat methani,* said to be of superior quality. The tree was left for three years and the procedure was repeated. According to Botta, wild-growing khat, known as *kat beledi,* had stronger effects and was little used.

Beitter also quoted Barbier de Meynard, who, writing in a journal on oriental languages, contended that the variations in the potency of the effects of khat were due to differences in the soil conditions where it was grown. Thus, there were three types of khat: the first had the most marked effects on the brain and could lead to madness, the second was milder and its effects could be compared with those of alcohol, while the third caused only insomnia.

In still another quotation, Beitter recorded that in the Harar district of Ethiopia, khat was cultivated in three ways: as a dwarf plant, an arborescent shrub and a shrubby tree. The dwarf plants, which had a maximum height of 0.4 m, had the most tender leaves, with a pleasant sugary taste when fresh. These were the most sought after and the most expensive. In the plants that grew to full height, the leaves were larger and, although they produced the same effects as the smaller leaves, they were less used because of their less pleasant taste.

Peters [2] subsequently described the cultivation of khat in the Harar district where it was grown in terraced plantations at an altitude of about 1,800 m above sea level. Coffee trees were interspersed with the khat, and millet was found in the spaces between the trees. Seed was rarely sown and cultivation was mainly from cuttings. After planting, artificial watering was provided for a period of about 40 days. Thereafter, the plants relied entirely on rainfall. The trees were three or four years old before the first crop was taken and thereafter yielded two crops a year. The trees were pruned annually to keep their height to approximately 5 m, as otherwise they would grow to well over 18 m. The older trees from which the main crops were obtained were 20–25 years old. No disease seemed to be known amongst the khat trees on the plantations visited. The khat was picked two or three times a week and sent to the markets in Harar, where it was accepted as fresh for a period of up to four days after picking. The bundles of khat were wrapped first in green, then in dry, banana leaves and their freshness was preserved by occasional moistening with water.

Getahun and Krikorian [5] have recently made an important contribution to the knowledge about khat by describing in considerable detail the early history, botany, cultivation, economics and sociological aspects of the use of *Catha edulis*, with special emphasis on cultural practices in the Harar district of Ethiopia.

Use

Most of the khat produced is used in the fresh state, when it is chewed to obtain stimulating effects. When fresh material is not available, a dried or powdered form of khat may be taken instead. Khat has also been used for certain medical purposes [2, 4] and as an adulterant of common tea [1].

The leaves and shoots of *Cassine* species, mainly *Cassine capensis* L. (also of the family Celastraceae), and the leaves from *Maësa* species have been mentioned as adulterants of khat [4, 6].

Botany and morphology

A review of earlier literature shows that there are reports of thorough investigations on the botany and morphology of khat. There are, however, certain drawbacks in connection with these sources, in that some of them are very difficult to obtain because they are old and rare (for example, Beitter's thesis [4] published in 1900), while others are concerned with only a very limited number of samples.

During recent years, intensive investigations on the chemical composition of khat have been carried out at the United Nations Narcotics Laboratory. It was considered of interest to compare the United Nations samples with the descriptions of khat found in the earlier literature. It was also hoped to provide information that would facilitate the identification of the types of khat on the market. An investigation was therefore made of 13 samples provided by the United Nations Narcotics Laboratory plus 3 herbarium specimens from the Botanical Museum of the University of Oslo, which were added for comparative purposes, identified as follows:

Samples from the United Nations Narcotics Laboratory

From the Yemen Arab Republic

1. Young shoots, 13–15 cm long, bought in Sana'a, May 1974; preserved in 96% ethanol

From Kenya

2. Dried (pressed) specimens of fresh khat bought at a market in Nairobi, June 1975
3. Dried (pressed) specimens of shoots, 13–25 cm long, collected at the Meru region, June 1975
4. Young shoots, 8–13 cm long, collected June 1975; preserved in 96% ethanol

***Samples from the United Nations Narcotics Laboratory** (continued)*

From Madagascar (collected November 1977)

5. Type: white. One young shoot with 10 opposite leaves and one shoot with 22 opposite leaves and clusters of fruits with ripe seeds
6. Type: red. Two young shoots with 8 and 12 alternate leaves
7. Type: white. One strongly branched shoot with 36 leaves arranged opposite and alternate
8. Type: red. One shoot with 15 alternate leaves
9. Type: red. One shoot with 12 alternate leaves of which two are obcordate and rather small (1.5 × 2 cm)
10. Type: red. Three shoots with alternate leaves
11. Type: white. Three young shoots, each with 3 alternate leaves
12. One branched shoot with alternate leaves
13. One shoot with 8 alternate leaves, one of which is clearly obovate

Samples from the Botanic Museum, University of Oslo

14. Flowering branches designated "*Catha edulis* Forsk. No. 1538 (4629). Nyassa Hochland Station Kyimbila, at 1,200 metres above sea-level. Sept. 3, 1912 Mg. A. Stolz"
15. Flowering branches designated "649 *Catha edulis* Våhl-Höchst. W. Schimper pl. Abyssin. Ed. II. Hohenach 1952. Prope ascum"
16. *Cassine capensis* L.

The investigation showed that most of the morphological elements important for the identification of khat had already been exactly described, although the accompanying illustrations were often inadequate. Therefore, an attempt has been made here to combine new illustrations with descriptions that are strongly influenced by older papers on the subject. A few new findings that seem to be of importance for identification are also described.

Shoott

The samples investigated consisted of young shoots (stems and leaves) and older shoots with leaves, flowers and fruits. The leaves are opposite or alternate in arrangement (figure I). Occasionally, both arrangements are found on the same twig. The shoots sometimes show heterophylly, one or more of the ordinary oval-lanceolate leaves being replaced by smaller, obcordate leaves (figure I*b*) that may resemble the leaves of *Cassine capensis* L. (figure VIII). Stipules can often be observed at the bases of the petioles.

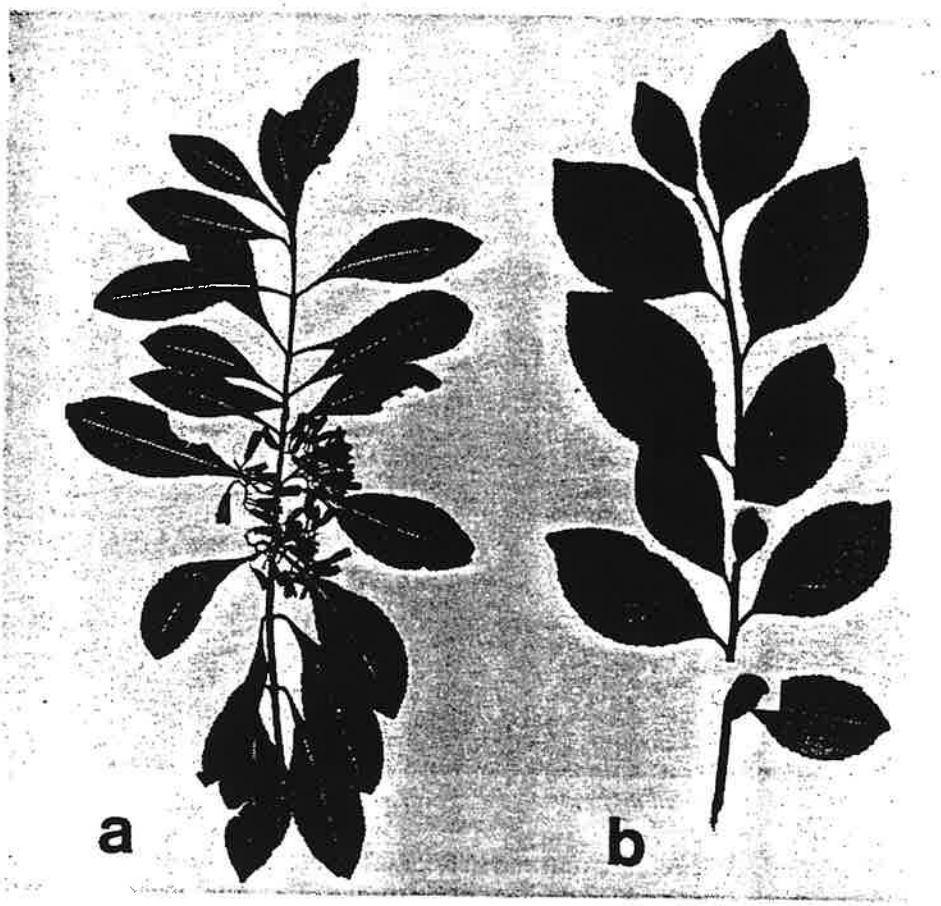

Figure I

Shoots with *(a)* opposite and *(b)* alternate leaves

Leaves

Macroscopical features

The leaves may vary considerably in their size, shape and colour according to such factors as degree of development and botanical origin. They are simple. 4–11 cm long and 1.8–5 cm wide at the widest part. They have a short, round petiole, 3–7 mm long. As described by Shadan and Shellard [7], the leaves are usually oval-lanceolate in shape with an acute or sometimes slightly acuminate apex and an acute symmetrical base. With the exception of a small portion near the base which is entire, the margin is serrate, showing 25–30 blunt teeth. The upper surface shows pinnate venation but this is more marked on the lower surface. A few of the lateral veins leave the midrib at a fairly wide angle (45°) but the majority leave at a narrow angle (25–30°) and immediately curve upwards. Near the margin the lateral veins anastomose to form a reticulate venation. See figure II*a*.

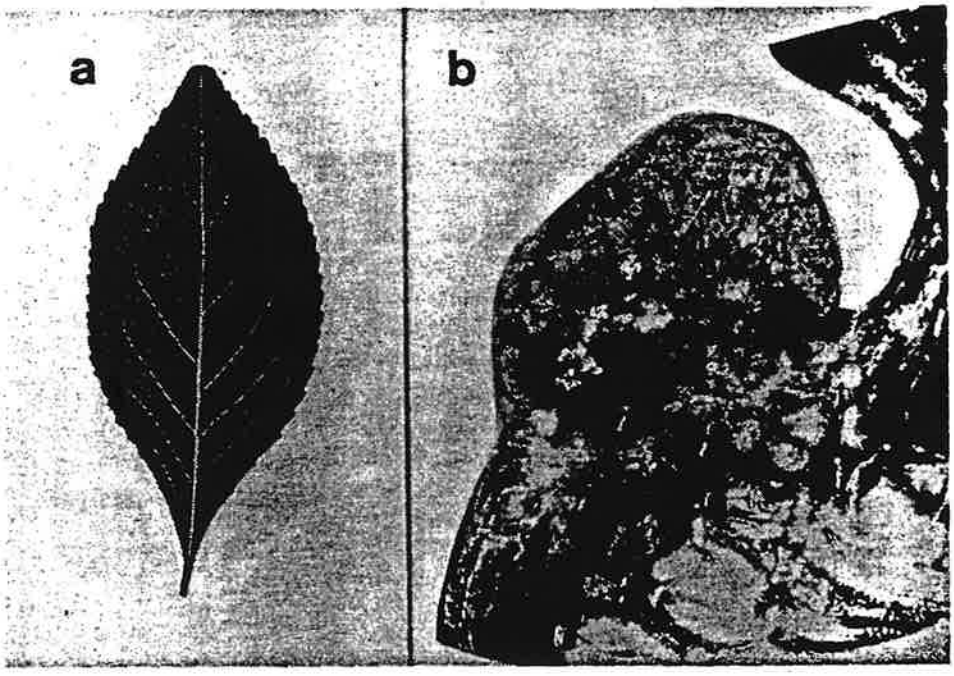

Figure II

(a) Leaf; *(b)* tooth-shaped projection found in the angles of the serrations

The youngest leaves are thin and slender. The surface is dull and they have a brownish green colour which darkens upon drying. The adult leaves are bright green, glossy, especially on the upper surface, and have a leathery appearance. The midrib and the most prominent veins on the lower surface may vary in colour from yellow to reddish brown. The distinction of types, such as "white" and "red", is probably connected with this fact (see, for example, samples listed as Nos. 5–11). The leaves are almost odorless and have a slightly astringent taste.

Microscopical features

In the serrate margins of the leaves, tooth-shaped projections are usually, but not always, found in the angles of the serrations (figure II*b*). The shape and size of these projections vary considerably from one sample of khat to another. and similar bodies are also found on the leaves of other celastraceous plants *(Cassine, Euonymus)*, as well as on leaves of plants belonging to other families (e.g. the common tea), for which reason they are of limited importance for the identification of khat.

Figure III*a* shows a transverse section of the adult leaf near the middle part of the lamina: there is little to be found that might form the basis for microscopical identification. The most characteristic feature is the midrib which,

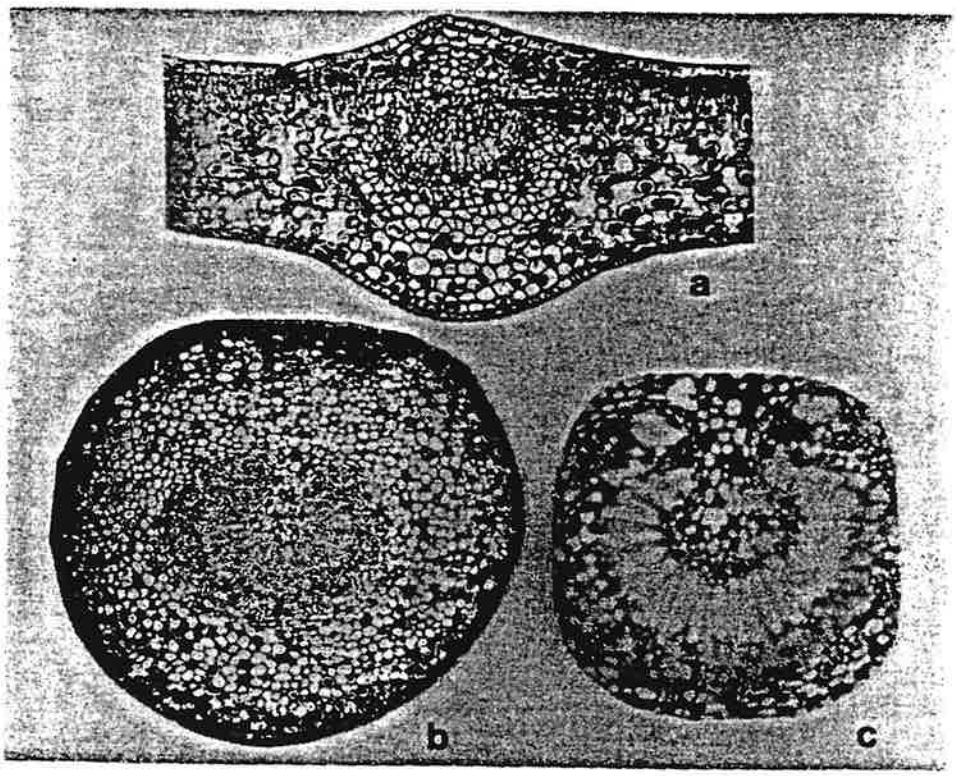

Figure III

(a) Transverse section of an adult leaf; *(b)* transverse section of the petiole; *(c)* crescent-shaped vascular strand

especially in the lower parts of the leaf, shows a crescent-shaped vascular strand. This can be easily observed in a transverse section of the petiole (figure III, *b* and *c*). Cluster crystals of calcium oxalate and cells with black contents (referred to in the older literature as "tanniferous cells") are scattered in the parenchyma. No starch appears to be present. A surface view of the lower epidermis (figure IV*a*) shows stomata of the ranunculaceous type and cluster crystals which occasionally appear in pairs in the same cell or in two small adjacent cells. Such "twin" crystals, as they have sometimes erroneously been called, have been indicated as a characteristic anatomical feature of khat leaves, but they are hard to find in a microscopical preparation and they may also occur in related species. It is felt, therefore, that they are of little value for identifying khat.

Figure IV*b* shows a transverse section of the young stem, a few millimetres below the base of two young opposite leaves. The stem is flattened with an elongated great pith and with thin layers of xylem on both sides. Then follow the cambium and a fibrous cortex.

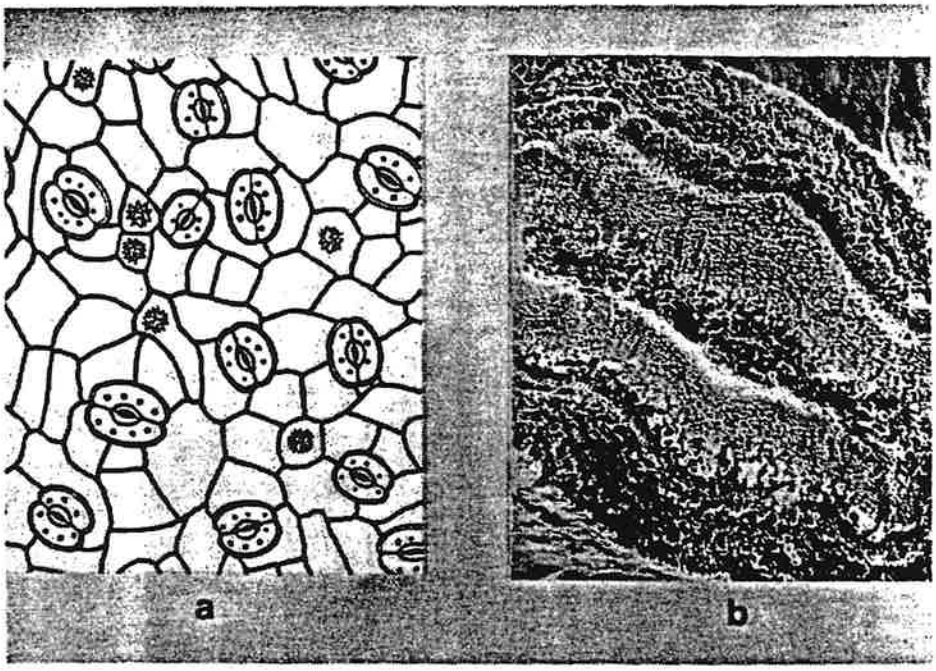

Figure IV

(a) Lower epidermis showing stomata and cluster crystals; *(b)* transverse section of young stem

Powdered leaves

The most characteristic elements of the powdered leaves have been described [7] as containing fragments of lamina with reticulate venation (figure V*e*); fragments of lower epidermis showing stomata surrounded by three or four (occasionally five) cells, some cells containing one or two cluster crystals of calcium oxalate 4–8 µm in diameter (figure IV*a*); fragments of upper epidermis with sinuous anticlinal walls (figure V*d*); fragments of thick-walled, slightly lignified fibres with lumen of variable width, often obliterated and branched at the ends (figure V, *b* and *c*); and fibre tracheids with lignified walls and elongated oval bordered pits (figure V*a*). Parenchymatous cells with cluster crystals of calcium oxalate (4–40 µm) and parenchymatous cells with dark contents ("tanniferous cells") may also be observed.

The shape and size of the fibres can be easily examined when leaf fragments are subjected to maceration according to Schulze's method [8]. In a wide test tube or small vessel 50–100 mg of $KClO_3$ are moistened with concentrated nitric acid and a few milligrams of small fragments of the leaves are stirred into the mixture, which is heated slightly and stirred until most of the tissue is dissolved. After dilution with water, the fibres are studied under the microscope.

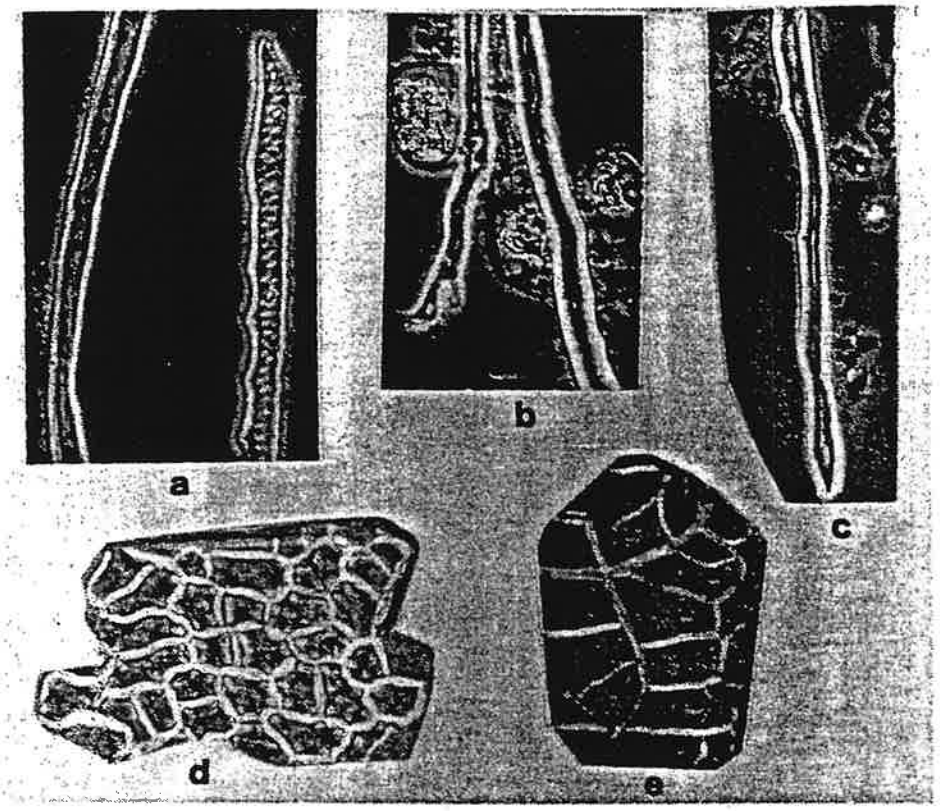

Figure V

(a) Fibre tracheids; *(b)*, and *(c)* slightly lignified fibres with lumen of variable width; *(d)* fragment of upper epidermis; *(e)* fragment of lamina with reticulate venation

Flowers

When dried, the flowers are about 2 mm in diameter and dark yellowish brown. A good description of the inflorescence and of the single flowers was given by Christ [9]. He reported that the inflorescence of *Catha edulis* is a short, typical cyme with five- or six-fold dichotomy originating from the axil. Sometimes the terminal flower is not fully developed. Each bifurcation is supported by short lanceolate bracts. The flowers, which are on short peduncles, are amongst the smallest within the dicotyledons. They are characterized by a thick, fleshy, hypogenous disc into the margin of which the peripheral parts of the flower are inserted, a common feature of the Celastraceae family (figure VI*a*). The base of the disc is surrounded by a calyx of five sepals, which are broad-ovate with fimbriate margins. Alternating with the sepals are five oblong-ovate petals of a yellowish white colour, also with somewhat fimbriate margins. Opposite the sepals are five subulate, lanceolate filaments carrying extremely small trilocular anthers.

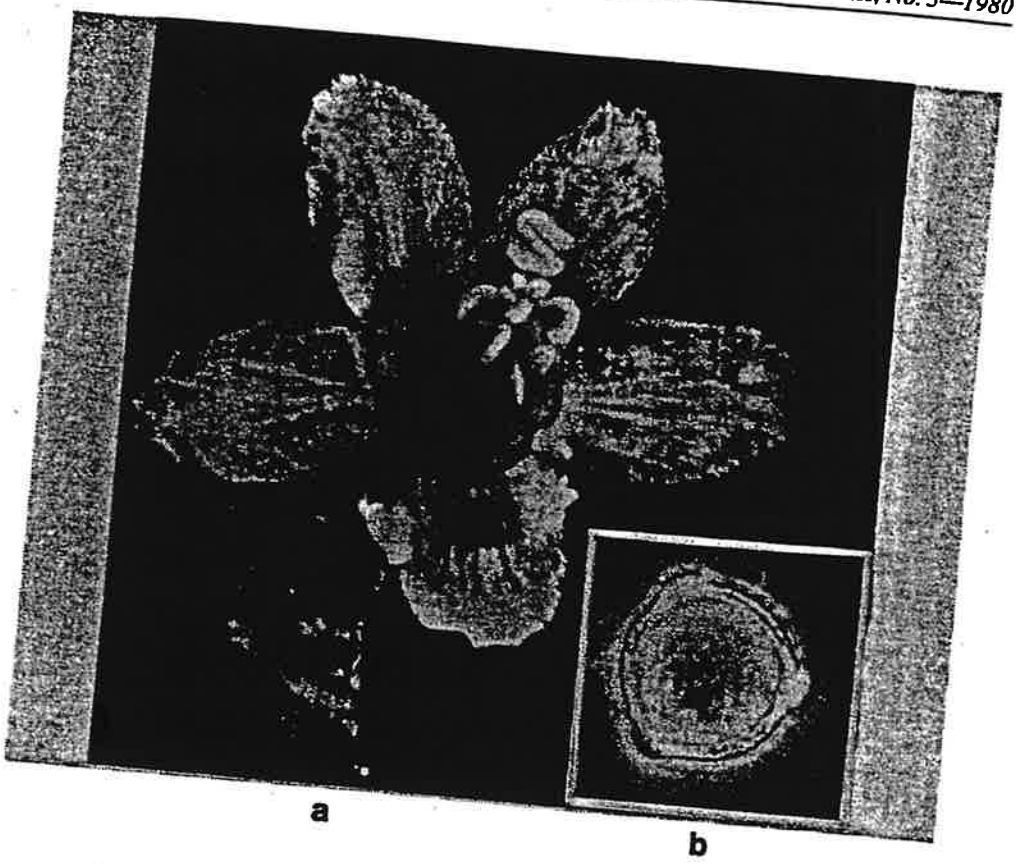

Figure VI

(a) **Flower;** *(b)* **pollen grain**

Between the ring of the stamina and the pistil is a green, swollen, broad ring, with five more or less reniform lobes, which are more or less encurved and opposed to the petals, so that the stamens appear to be embedded below the indentations.

A pollen grain with three germ spores is seen in figure VI*b*.

Fruit and seeds

The following information is taken mainly from Beitter [4], who provided an adequate description of the fruit and seeds.

The fruit has an average length of 8–10 mm (longer ones are also found in Ethiopian plants) and a diameter of 2–3 mm. At the base there is a short stem, 3–8 mm in length, above which is a disc on to which the organs of the flower are inserted, and a somewhat pointed conical capsule, thicker towards the top and flattened (figure VII*a*). It opens when ripe, with three or four carpels that remain in one piece in the lower half, while the upper half is opened wide enough

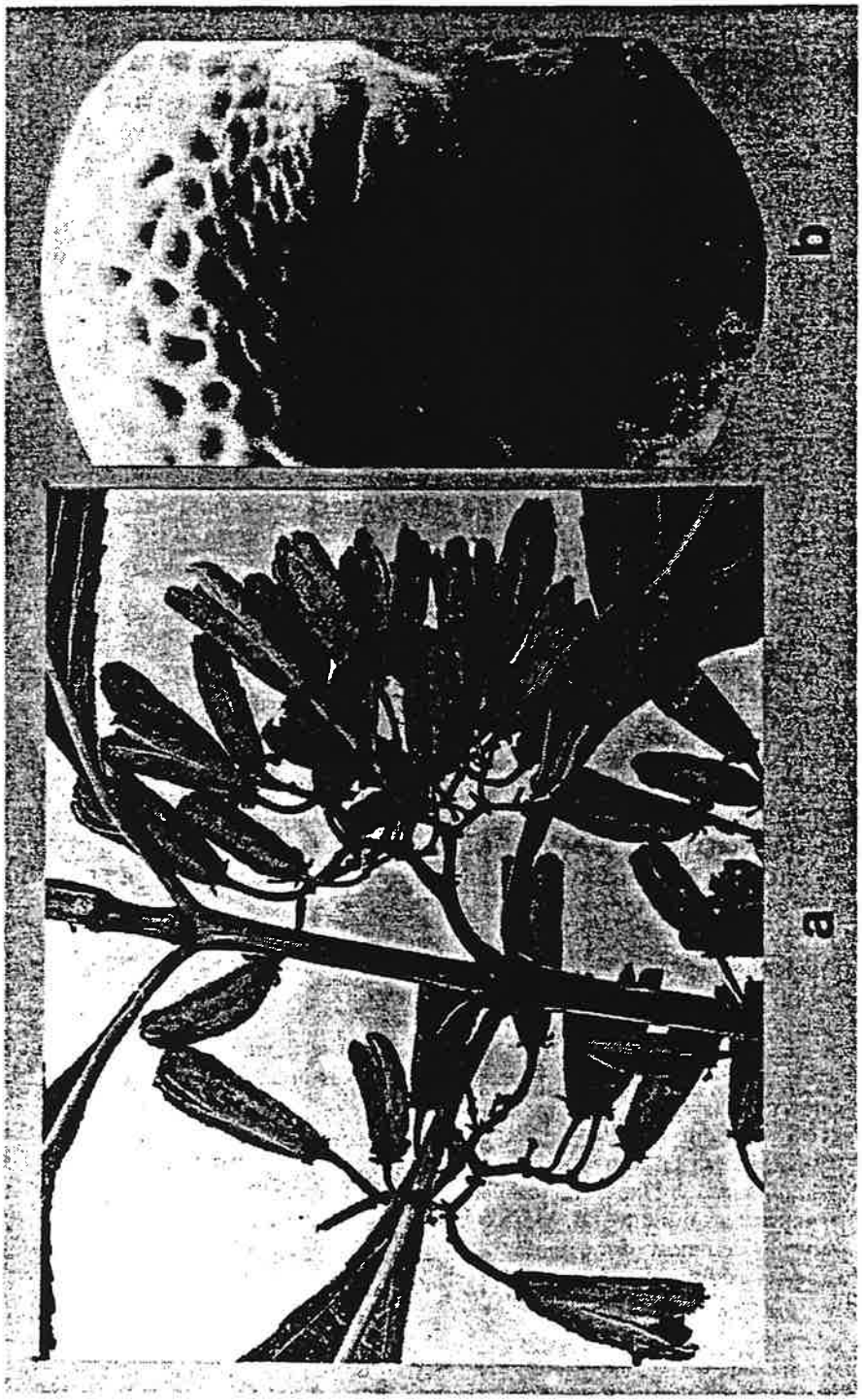

Figure VII
***(a)* Branch with ripe fruits; *(b)* seed, outer surface**

so that the seeds can escape upwards. The outer surface of the ripe fruit is light-brown, dry and rough. The individual valves are divided into two locules by a wall which thickens in the lower half, so that the fruit is actually 6–8 loculate. The separation wall is very thin towards the top, leaving space for two seeds. It is rare for both seeds to mature; usually only two or three seeds develop in the whole fruit. The seeds are small and brown, with a rough, oil-containing testa (in disagreement with Christ [9], who described it as smooth). They are compressed and on one side they have a keel-shaped indentation in which the raphe is placed. The lower tip of the seed is covered by a fine, dry, white, membranous arillus which sometimes grows upwards on both sides of the seed. It is often up to twice as long as the seed itself (figure VII*b*).

Adulterants of khat

Figure VIII shows a flowering branch of *Cassine capensis* L. The leaves of this plant are reported to be the most common adulterant for khat. In comparing figure VIII with figure I*b* it will appear that the normal leaves of the two plants are very different. It is only the obcordate leaves found occasionally in *Catha edulis* that show a certain resemblance to the leaves of *Cassine.*

Identification of khat

Khat has very few morphological and anatomical features that would serve as a basis for the purpose of identification. It is therefore strongly recommended that authentic samples of khat should be available for comparative purposes and that identification should be based on more than one method. A combination of methods for the identification of khat has recently been worked out in this laboratory [10].

Acknowledgements

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Three herbarium specimens, one of *Cassine capensis* and two of *Catha edulis*, were put at the author's disposal by the Botanical Museum of the University of Oslo, and a sample of *Euonymus*, by the Botanical Garden of the University.

Thanks are also due to Dr. Morten Laane, Botanical Laboratory, University of Oslo, who provided most of the photographs, and to Konsulent I. Gjöen, University of Oslo, who provided a drawing.

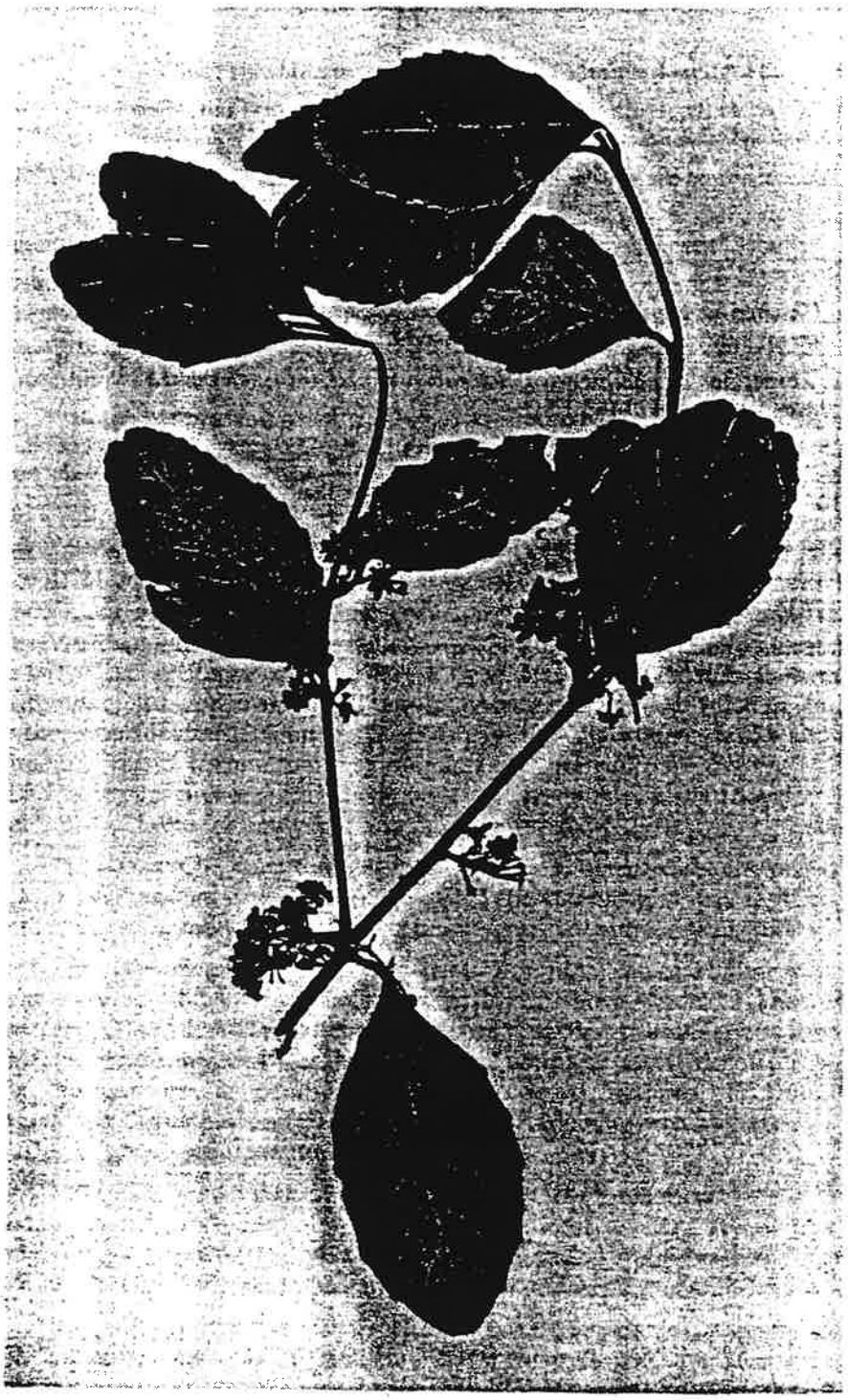

Figure VIII
Flowering branch of *Casine capensis* L. (about 1:1)

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Photo 5 (Courtesy of John F. Casale, DEA Special Testing and Research Laboratory, Dulles, VA)

are not commonly encountered in Minnesota, and bricks with logos are rare. In this case, the brick is suspected to have been shipped from the Chicago, Illinois area.

* * * * *

SELECTED INTELLIGENCE BRIEF

Khat

DEA Intelligence Division
International Strategic Support Section
Europe, Asia, Africa Strategic Unit

[(202) 307-8726]

[Unclassified; Reprinted with Permission]

Status in International Drug Trafficking

Although khat is illegal in the United States, it is legal throughout much of Europe, East Africa, and the Arabian Peninsula. Individuals of East African and Middle Eastern descent are most often responsible for the importation, distribution, possession, and use of khat in the United States.

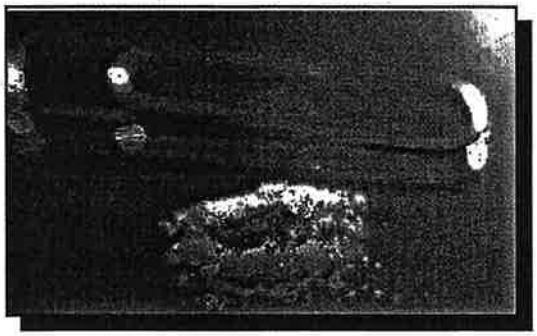
Background

A khat shrub

Khat is a naturally occurring stimulant derived from the *Catha edulis* shrub. This shrub is primarily cultivated in East Africa and the Arabian Peninsula. The use of khat is an established cultural tradition for many social situations in those regions. Khat is also known as *Abyssinian tea*, *African salad*, *oat*, *kat*, *chat*, and *catha*. Khat has two active ingredients, cathinone and cathine.

Cathinone is a Schedule I substance that produces a euphoric effect similar to amphetamine in that it stimulates the central nervous system. The cathinone in khat begins to degrade 48 hours after the plant has been cut. Khat that has been refrigerated or frozen will retain its cathinone potency for a longer period.

Cathine is a Schedule IV substance that produces a much less intense stimulant effect than cathinone; however, it does not lose its potency after harvesting.



Methcathinone

Methcathinone, commonly called *cat*, is occasionally confused with khat. Methcathinone is a synthetic Schedule I substance that has a similar chemical structure to the cathinone in the khat plant. Methcathinone is produced in clandestine laboratories and sold as a methamphetamine alternative. Ephedrine and/or pseudoephedrine are the main precursor chemicals used in methcathinone synthesis. The addictive properties and side effects of this synthetic are more intense than either of the naturally occurring khat substances.

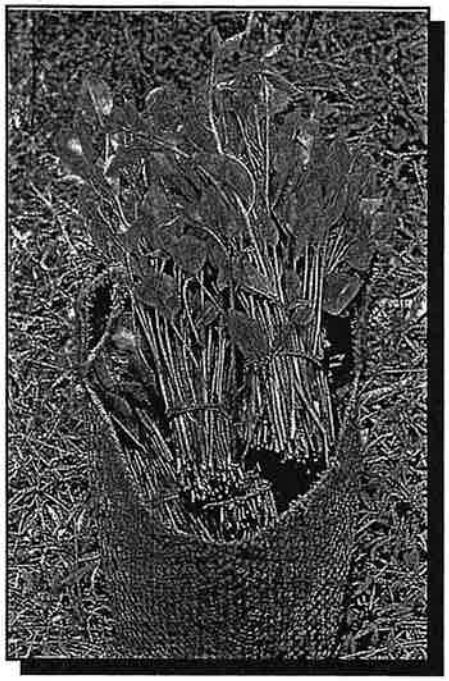
Recent History

Several million people may currently be using khat worldwide; the largest concentrations of users are in the regions surrounding the Middle East. U.S. Customs Service (USCS) seizures of khat have risen from around 800 kilograms annually in 1992 to over 37.2 metric tons in 2001. The price of khat ranged from US $30 to US $60 per kilogram in 1992. Although current kilogram prices for khat are not available, the price of khat ranged from US $15 to US $50 per bundle in 1998. [Note: There is no method of converting bundles to kilograms, because the weights of the bundles vary - some bundles can weigh almost nothing while others can weigh much more. In addition, a bundle of khat can contain between 20 and 40 stems; the variance of weight and number of stems accounts for the wide range of prices per bundle. Seizures of khat, however, can be measured and are measured in kilograms.]

Cultivation

Khat is an important part of the economy of many producer countries, particularly Somalia and Yemen. Press reports from Yemen state that more than US $2 billion are spent annually by Yemenis to purchase khat, which is often grown on land that is unsuitable for other crops.

[Note: Although khat is cultivated on land that is currently unsuitable for other crops, the cultivation of khat precludes the land's development for other purposes.]



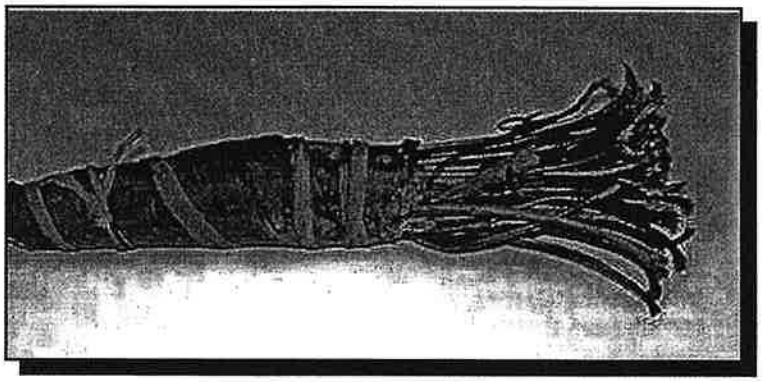
At a khat cultivation area

Khat is grown in export quantities in countries such as Kenya and Ethiopia; it is Ethiopia's fourth largest export according to U.S. embassy reporting, and the recreational use of khat is widely accepted there. Over 33 percent of Yemen's gross national product is associated with the cultivation, consumption, and exportation of khat. The World Health Organization reports that the cultivation and use of khat has profound socioeconomic consequences on countries and individuals. The cultivation of khat requires scarce land and water resources that could be put to other uses. Khat use is costly and potentially addictive. Widespread frequent use of khat impacts productivity because it tends to reduce worker motivation.

The only known case of khat cultivation in the United States occurred in September 1998, when 1,076 khat plants were seized in a raid in Salinas, California. Sophisticated irrigation techniques were used in this outdoor-grow operation. The individual involved was of Middle Eastern origin; he earned approximately US$10,000 per month in khat sales.

Because the potency of the cathinone in the khat is reduced as the plant material dries, shipment by air is the most common method of transport.

Trafficking



A bundle of khat

Khat is usually shipped already packaged into bundles, and wrapped in plastic bags or banana leaves to retain moisture and freshness. Khat is generally smuggled in passenger luggage, overnight express mail (USPS, UPS, DHL, etc.), or shipped as air cargo and falsely labeled as "vegetables." According to the U.S. Food and Drug Administration, khat is sometimes falsely labeled and shipped to the United States as *molokheya*, an Egyptian vegetable.

Most khat seized in the United States has been seized from immigrants of Somalia, Ethiopia, Yemen, Eritrea, and other countries where khat use is common. The USCS makes most of its khat seizures at the JFK International Airport in New York from arriving passengers, overnight

express mail, and air cargo. Of the over 27 metric tons seized by the USCS in FY 1998, almost 18 metric tons were seized from flights arriving from Great Britain. Most cases of khat trafficking in the United States are prosecuted at the state level rather than in the federal court system.

Use/Abuse of Khat


Two men chewing khat

Khat has been used since antiquity as a recreational and religious drug by natives of Eastern Africa, the Arabian Peninsula, and the Middle East. Khat is legal in many countries, including Great Britain where khat can be legally imported, distributed, used, and/or exported. Khat has long been an acceptable substitute for alcohol among Muslims. During the period of Ramadan, the use of khat is popular to alleviate fatigue and reduce hunger. Although khat can be abused, it is often used in a social context similar to the manner in which coffee is consumed in other parts of the world. Reports from Yemen indicate that khat is consumed by 3 out of every 4 Yemenis, and accounts for more than 40 percent of the average family budget.

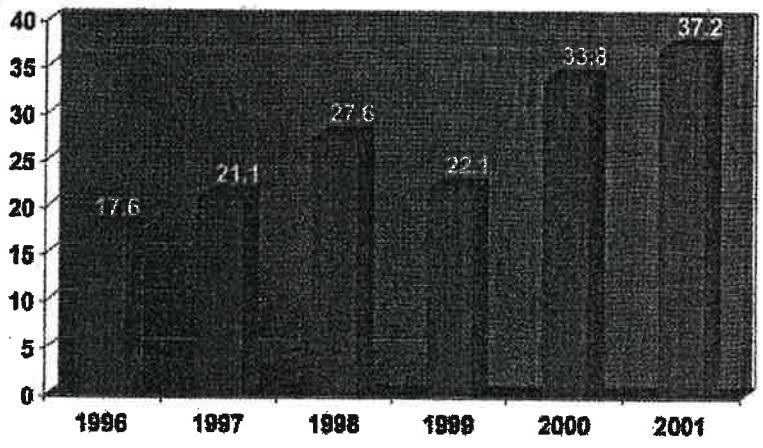
Khat is typically chewed like tobacco. The fresh leaves, twigs, and shoots of the khat shrub are chewed, and then retained in the cheek and chewed intermittently to release the active drug. Dried plant material can be made into tea or a chewable paste, but dried khat is not as potent as the fresh plant product. Khat can also be smoked and even sprinkled on food.

Chronic khat abuse can result in symptoms such as physical exhaustion, violence, and suicidal depression, which are similar to amphetamine addiction. Common side effects include anorexia, tachycardia, hypertension, insomnia, and gastric disorders.

Statistics

Seizures of Khat at U.S. Ports of Entry
Metric Tons

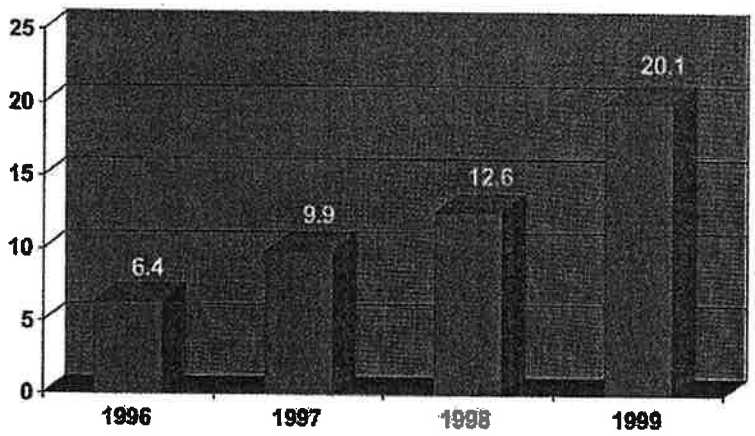
SOURCE: El Paso Intelligence Center (EPIC) from USCS data



Seizures of Khat (Non-U.S.)
Metric Tons

SOURCE: INTERPOL

Statistics for the years 2000 and 2001 are unavailable.



Key Judgments

The amount of khat seized in the United States has been steadily increasing; it appears to be related to the increasing number of immigrants from Somalia, Ethiopia, Yemen, Eritrea, and other countries where khat use is common. Although it is hard to predict future immigration trends, it seems likely that the importation of khat will continue to increase to meet the demand of those ethnic groups who are accustomed to using it.

It does not seem likely at this point that khat use will expand beyond the ethnic Somalian, Ethiopian, Yemeni, and Eritrean communities. There is no indication that khat is marketed outside these ethnic communities although it appears to be readily available.

* * * * *

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THE JOURNAL EXCHANGE

From the Editor: A partial collection of the journal *Forensic Science International* was offered for donation in the April 2002 issue of *Microgram Bulletin*. Over 25 requests for this collection were received by the DEA's Office of Forensic Sciences, and the collection was eventually donated to a small library collection of forensic journals in the midwestern U.S.

Previous efforts by the Editor to donate this collection through the various textbook and journal clearinghouse list-servers (that communicate via email with many thousands of libraries world-wide) were completely unsuccessful. Therefore, the level of interest expressed by the *Microgram* readership (even though a better targeted audience) came as a surprise, and suggests a need for a more formal journal exchange service. This solicitation is the first effort towards that goal.

If any subscriber is interested in donating any forensic or analytical chemistry journal/textbook or journal/textbook collection to a fellow subscriber or library, *Microgram Bulletin* is willing to list the offered materials and the associated contact information in a future issue. The format should follow that used in the April 2002 *Microgram Bulletin* for the aforementioned offer of the *Forensic Science International* collection, and sent via email to the *Microgram* Editor at: rklein@dialup.usdoj.gov Only items for donation (not for sale) will be considered for publication, and donations to libraries should adhere to journal restrictions and/or time limits (if any) on such offers.

At present, the journal exchange will be published on a quarterly basis. This will be adjusted (or discontinued altogether) in accordance with the level of interest.

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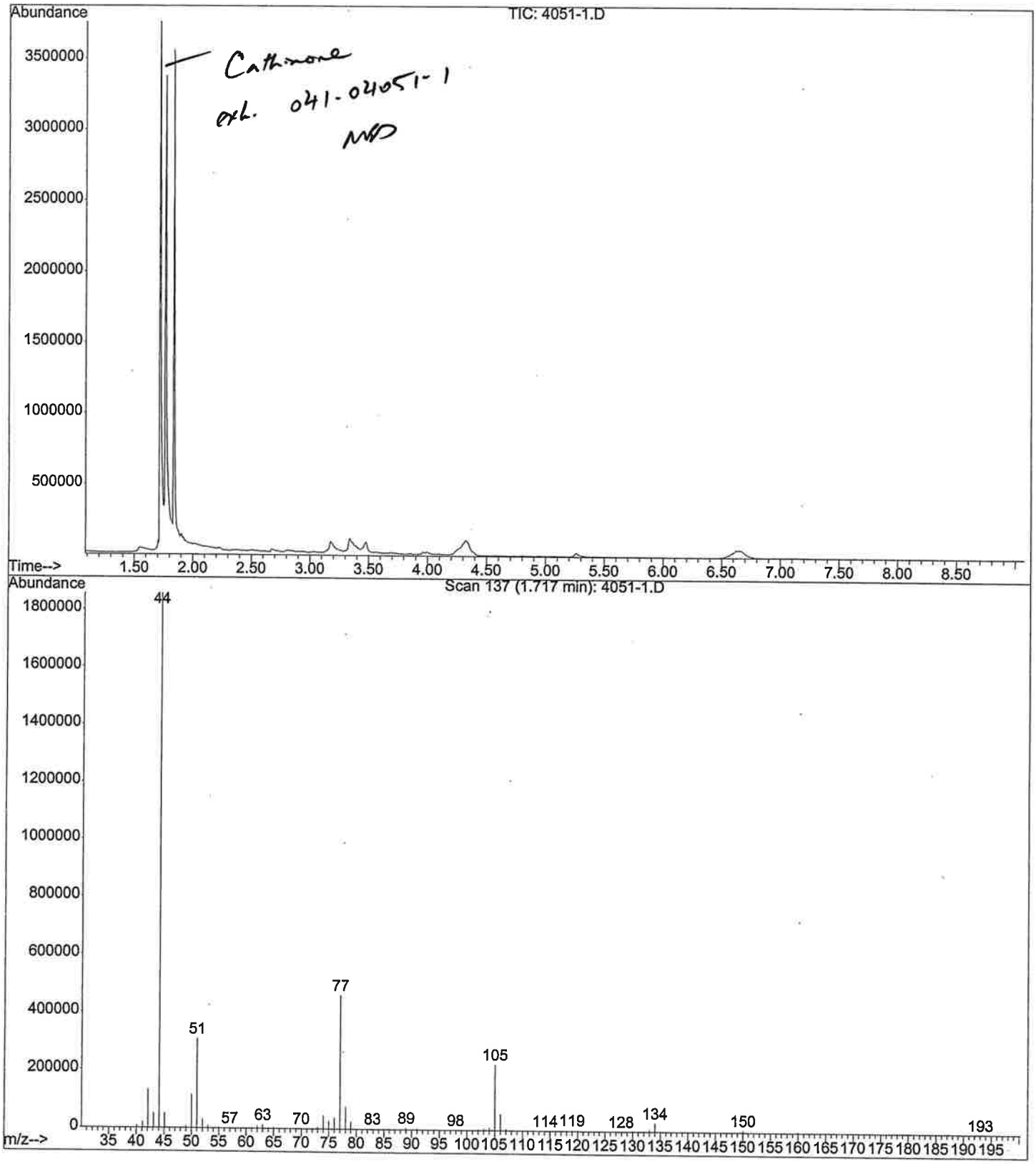

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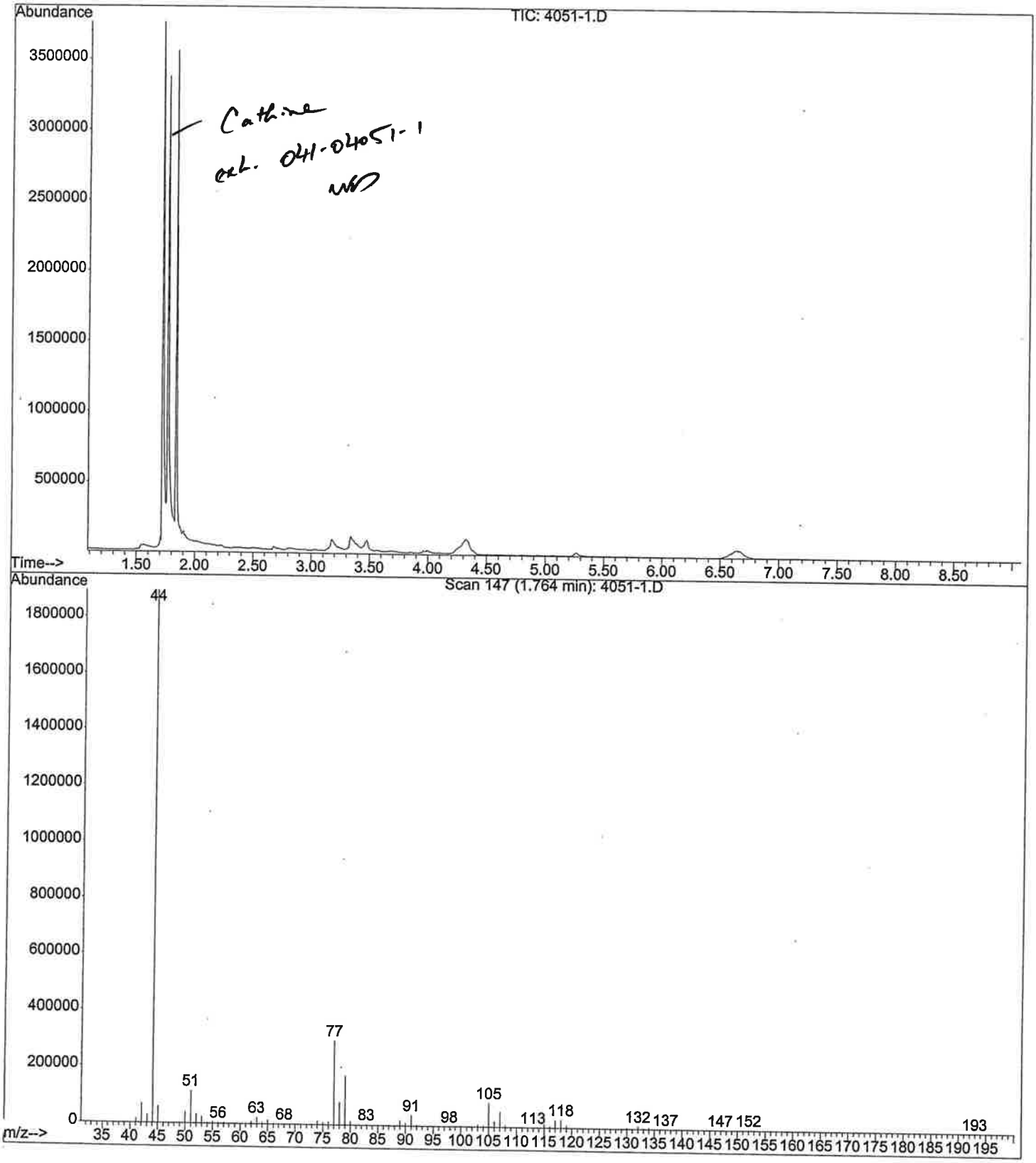

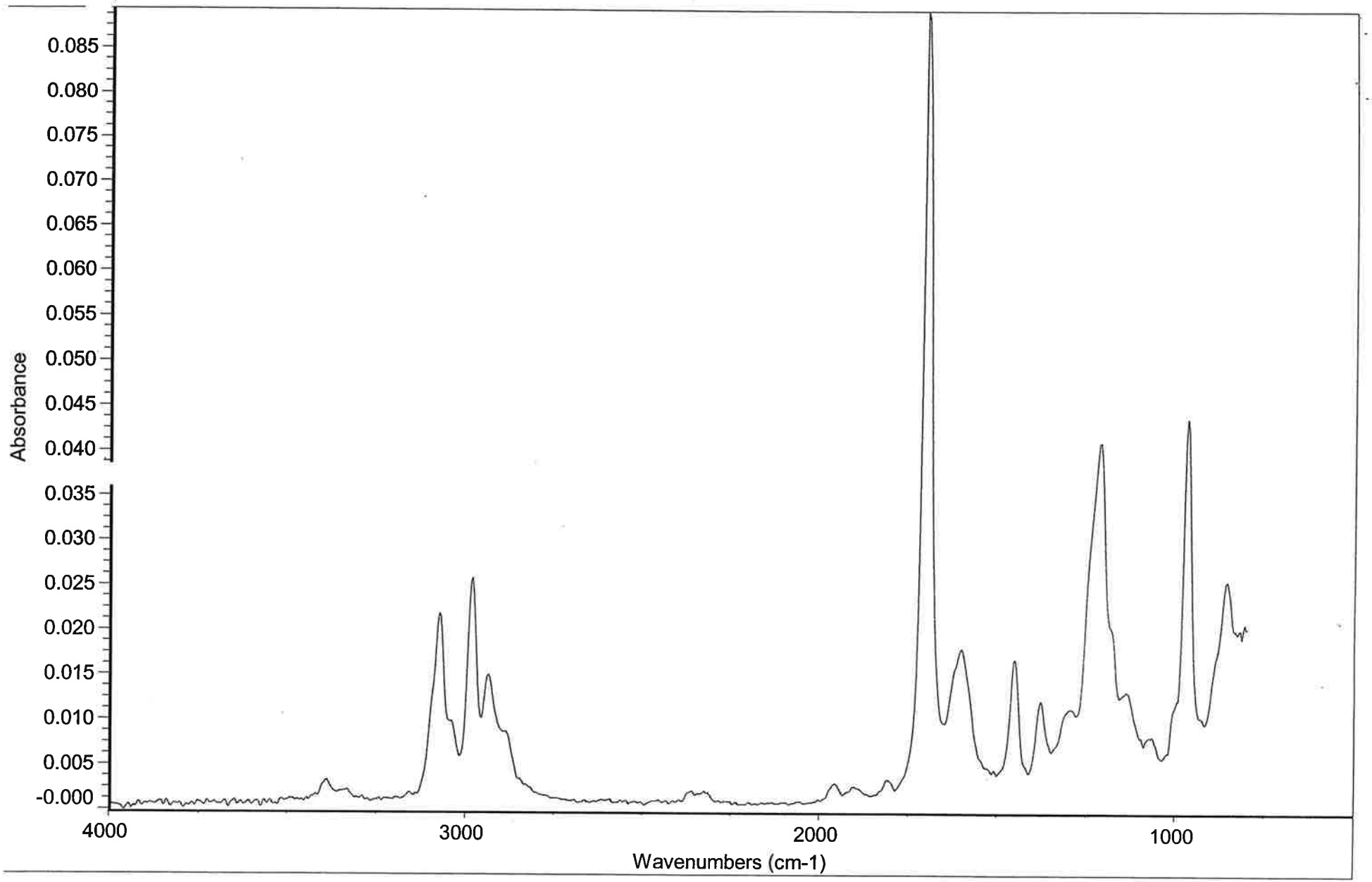

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Cathinone - MED

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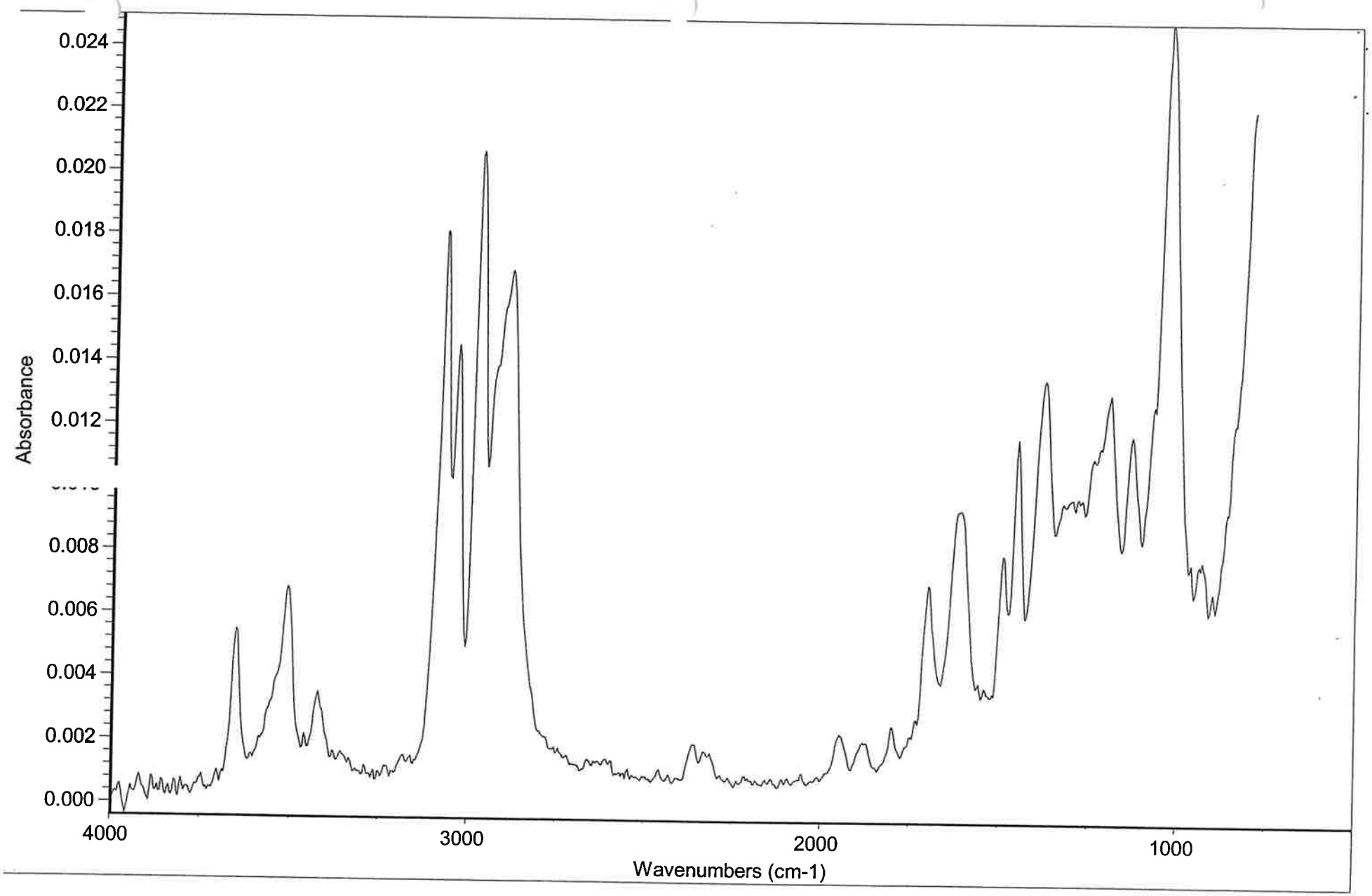

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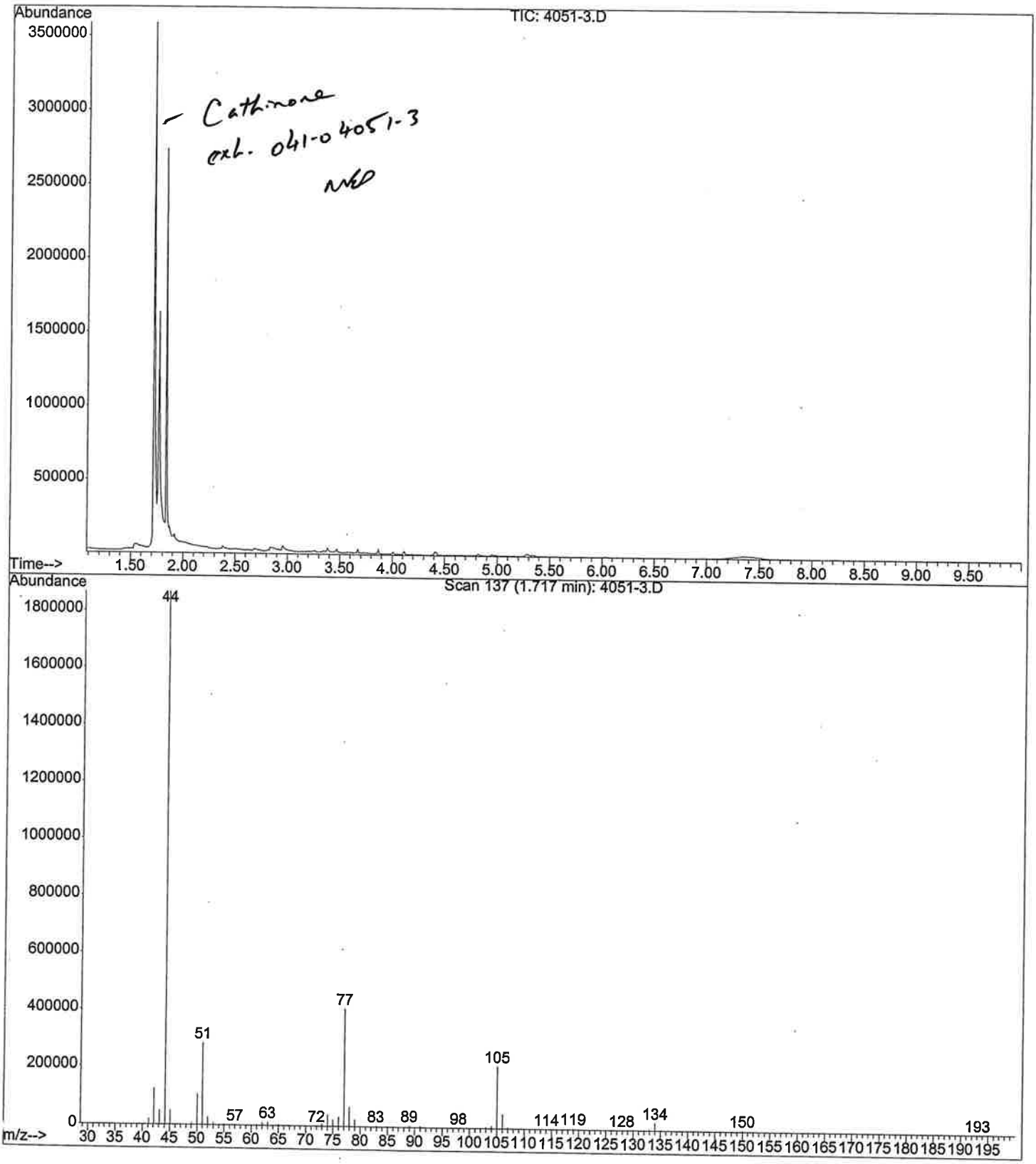

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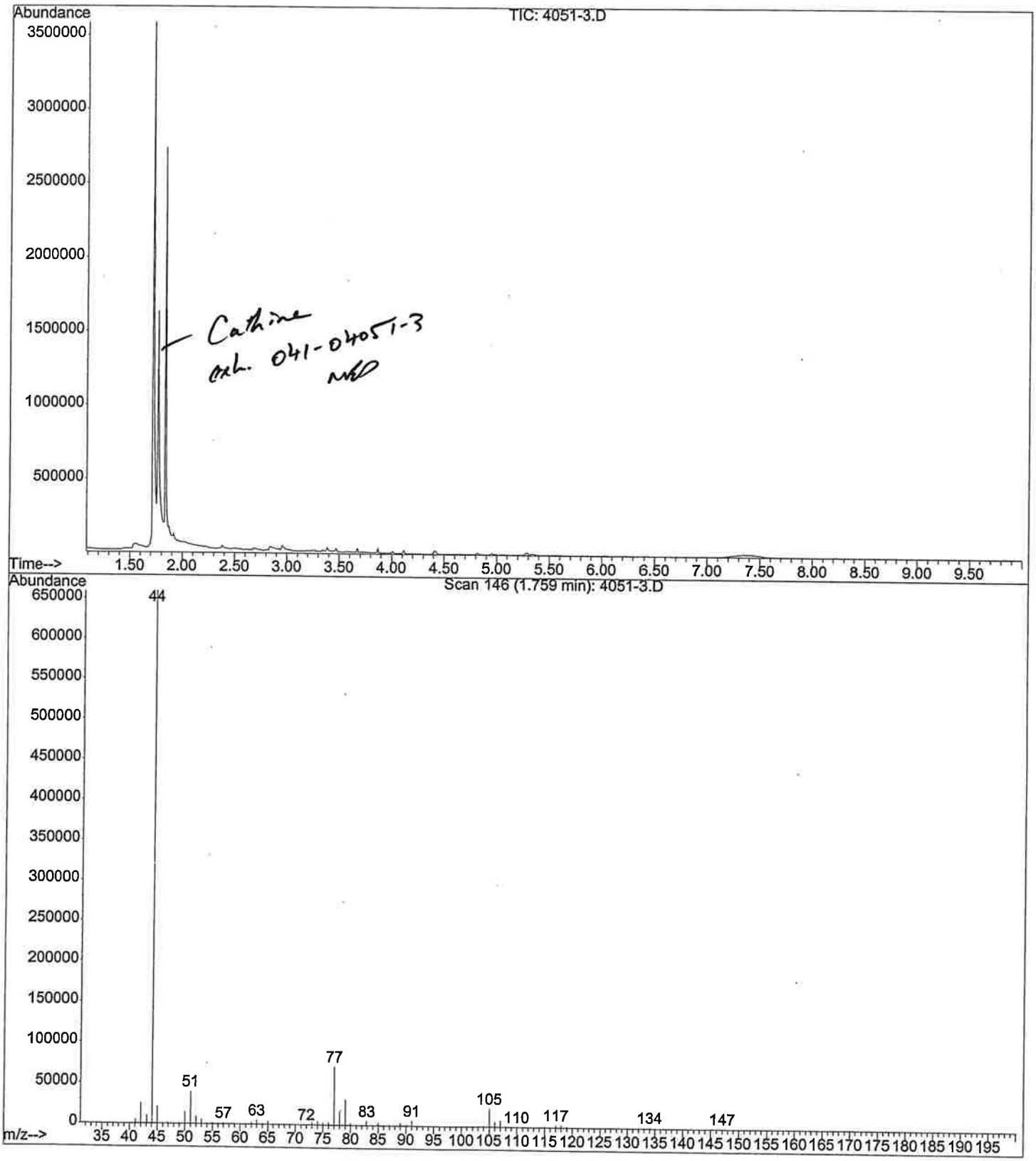

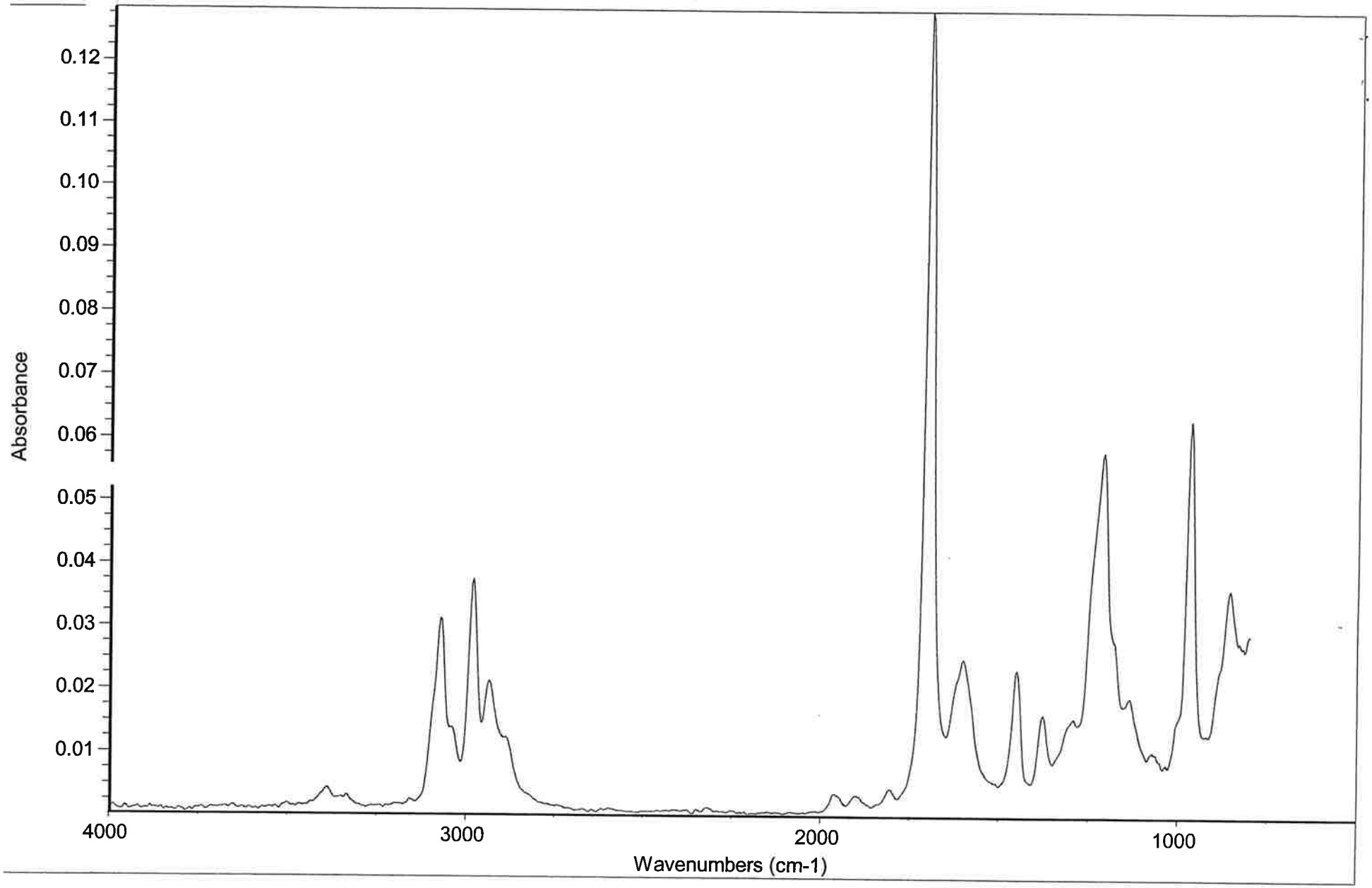

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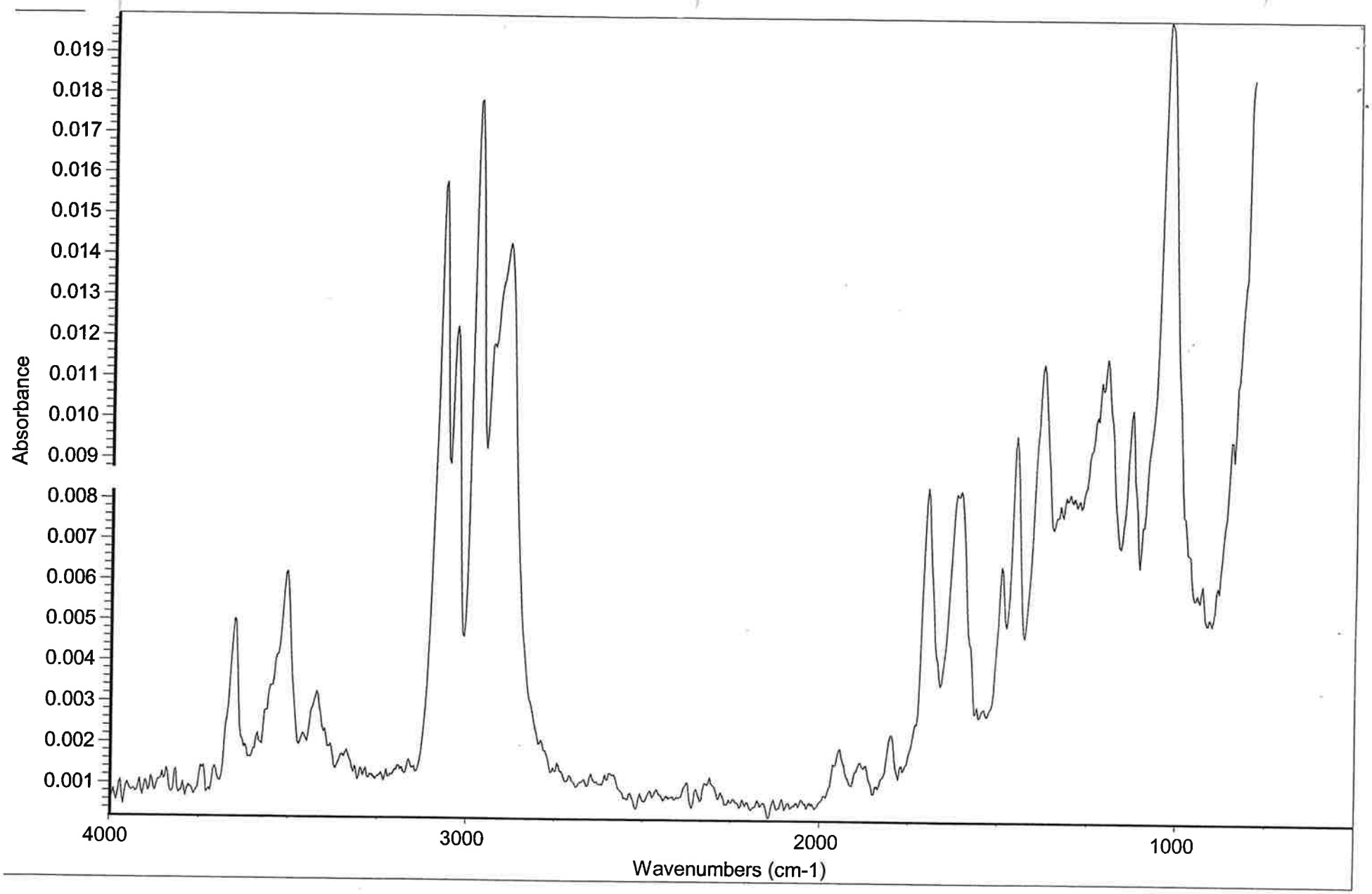

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