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# Cannabis improves night vision: a case study of dark adaptometry and scotopic sensitivity in kif smokers of the Rif mountains of northern Morocco

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**Abstract**

Previous reports have documented an improvement in night vision among Jamaican fishermen after ingestion of a crude tincture of herbal cannabis, while two members of this group noted that Moroccan fishermen and mountain dwellers observe an analogous improvement after smoking *kif*, sifted *Cannabis sativa* mixed with tobacco (*Nicotiana rustica*). Field-testing of night vision has become possible with a portable device, the LKC Technologies Scotopic Sensitivity Tester-1 (SST-1). This study examines the results of double-blinded graduated THC administration 0–20 mg (as Marinol®) versus placebo in one subject on measures of dark adaptometry and scotopic sensitivity. Analogous field studies were performed in Morocco with the SST-1 in three subjects before and after smoking *kif*. In both test situations, improvements in night vision measures were noted after THC or cannabis. It is believed that this effect is dose-dependent and cannabinoid-mediated at the retinal level. Further testing may assess possible clinical application of these results in retinitis pigmentosa or other conditions.


*Keywords:* Cannabis; Medical marijuana; Ethnobotany; Night vision; Ophthalmology; Visual testing

## 1. Introduction

*Cannabis sativa* L. (Cannabaceae) has been utilized in ethnomedicine for millennia. Previous studies have examined its application in Moroccan ethnobotany (Merzouki and Molero Mesa, 1999, 2002; Merzouki, 2001), in psychiatry (Russo, 2001a), migraine (Russo, 1998; Russo, 2001b), other pain conditions (Russo, 2002b), and in obstetrics and gynecology (Russo, 2002a).

West reported in 1991 his observations that Jamaican fishermen who smoked or ingested a crude tincture of cannabis were apparently able to see and navigate their boats through dangerous coral reefs in the darkness of night (West, 1991) under conditions that seemed highly improbable. No objective measurements of the subjects were undertaken. Contemporaneously, a similar observation was made in cannabis smokers in Morocco by two members of this group among a population of fishermen with no knowledge of their Jamaican counterparts (Merzouki and Molero Mesa, 1999) (translation from French by EBR):

> "Vision: Data were collected during a sojourn effected with the fishermen of the village of Chmaâla (situated on the Mediterranean coast about 100 km east of Tetouan) in July 1991. During our enquiry, one remarked on the particular obscurity of moonless nights and the easy mobility of the fishermen in preparing their launch into the sea. The responses of our informants related the anecdote that they attribute their ability to see [in the dark] to the consumption of *kif* [Moroccan cannabis mixed with tobacco (*Nicotiana rustica*)] that they spend entire hours smoking before getting into their barques."

Claims of cannabis effects on vision are longstanding, but usually negatively oriented, particularly in the Islamic literature. Ibn Sina reported in Book II of his classic, *Canon of Medicine*, in Persia in the 11th century that cannabis

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Fig. 1. Field of cannabis growing near Zoumi, Rif Mountains, Morocco, June 2002.

darkened vision (Avicenna, 1294), and this allegation was repeated by al-Ghazzi in Damascus in the 15th century (Hamarneh, 1978) and in a 19th century Afghan love poem (Mathers, 1920). Modern investigation of the phenomenon has been scant, suggesting a decrement in dark adaptation in chronic cannabis smokers in Costa Rica, but not attaining statistical significance (Dawson et al., 1977). In this publication, for the first time, we examine the results of a field study of night vision in cannabis smokers employing objective measures with a scientifically standardized technique.

## 2. Methodology

Objective assessment of night vision has recently become possible with the development of a portable device, the LKC Technologies Scotopic Sensitivity Tester-1 (SST-1; Gathersburg, MD, USA) (Peters et al., 2000), proving comparable in reliability and sensitivity to a standard device. The SST-1 has previously been employed to assess dark adaptation in vitamin A deficiency (Abbott-Johnson et al., 2002; Huerta et al., 2002). Scotopic retinal sensitivity after 30 min dark adaptation has proven to demonstrate high reliability

Fig. 2. High-grade sifted Moroccan cannabis supports combustion.

Fig. 3. *Kif*, a *Cannabis sativa/Nicotiana rustica* mixture in *sebsi* pipe.

and reproducibility over 6-week intervals in normal subjects (Levy and Glovinsky, 1997). Similarly, the SST-1 demonstrated consistency such that repeated testing in normals of dark adaptation thresholds provided identical results in 9 out of 10 eyes, with one subject displaying a 1 dB difference in a single eye (Abbott-Johnson et al., 2002).

The hypothesis that alleged improvement in night vision was due to the effects of $\Delta^9$-tetrahydocannabinol (THC) was initially assessed by a double-blind trial of 0–20 mg of oral Marinol® (dronabinol, synthetic THC) in a 50-year-old male previously familiar with the medication effects, after informed consent, in accordance with the Declaration of Helsinki. Dark adaptation was assessed employing a full-field green LED ($\lambda_{max} = 572$ nm) not requiring fixation, with a 0.5 s flash stimulus, and intensity adjustable over 3 log unit range (=1000-fold difference), in 0.1 log unit steps measured in decibels (dB) with maximum stimulus $-2.35 \log cd/m^2$ at 30 dB. Scotopic sensitivity was similarly measured, but the stimulus was 4 s of 1 Hz sine wave flicker (Peters et al., 2000). Essentially, the subject was asked whether a given light stimulus was perceptible, and subsequent single integer decrements were effected in the stimulus gain until no longer visible. The Dark Adapted and Scotopic Sensitivity Limits were defined as the lowest

Fig. 4. Experimental test subject with LKC SST-1 device in background.

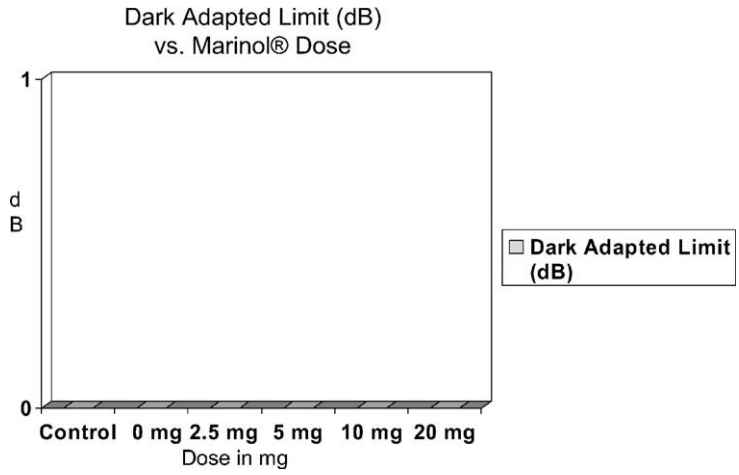


Fig. 5. Dark Adapted Limit (dB) vs. Marinol® dose. No changes are noted as this subject was sufficiently sensitive as to still perceive the stimulus at the lowest instrument setting.

possible intensity stimulus that a subject was able to see on two of three trials. The particular device employed in this and the field trials was calibrated, and demonstrated no variance in the appropriate test range to the nearest 0.1 dB.

Field testing was subsequently undertaken in the Moroccan Rif Mountains in June 2002. This population and the social milieu of cannabis culture to the local economy have been previously examined in great detail (Merzouki, 2001). *Cannabis sativa* is cultivated in the area (Fig. 1), and is traditionally made into *kif*, a sifted product of varying grades (Merzouki and Molero Mesa, 2002) containing significant amounts of THC and cannabidiol (CBD). For this study, high-grade sifted cannabis (Fig. 2) was mixed with tobacco (*Nicotinana rustica* L., Solanaceae) in a 2:1 ratio (Clarke, 1998; Merzouki and Molero Mesa, 2002), and smoked as *kif* by subjects employing a traditional *sebsi* pipe (Fig. 3). Each *sebsi* pipe bowl, or *chkaf*, containing an estimated 1.0 $cm^3$ volume, provided two to three inhalations.

Three *kif*-experienced Moroccan male volunteer subjects, aged 32–48 years, were recruited and were given informed consent in Arabic in compliance with the Declaration of Helsinki. All had normal vision and ophthalmological evaluations performed contemporaneously, including visual acuity, observation of external ocular movement, pupillary symmetry and reaction, and funduscopic examination. All were tested experimentally after their first *kif* exposure of the day and a uniform cannabis/*Nicotiana rustica* mixture was employed. Each subject was blindfolded for 30 min, underwent a control trial, with the same procedure repeated after numerous inhalations of the *kif* mixture (Fig. 4).

## 3. Results

Results from the single subject double-blind dose escalation THC experiment demonstrated that this individual was

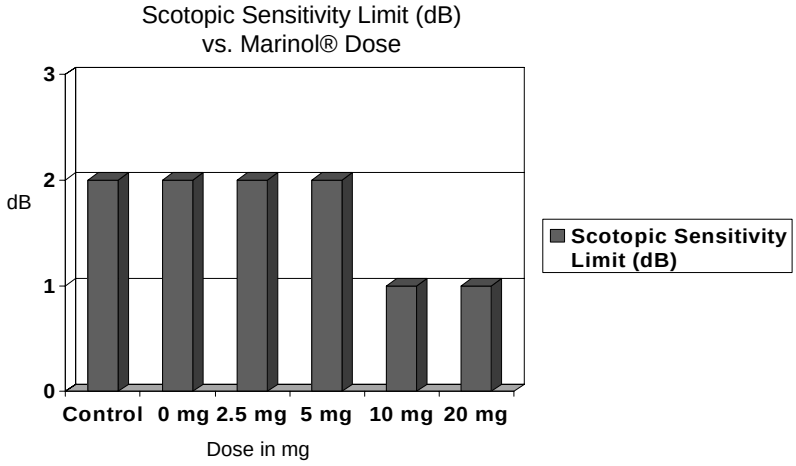


Fig. 6. Scotopic Sensitivity Limit (dB) vs. Marinol® dose. A decrement in sensitivity is observed at 10 and 20 mg of Marinol. See texts for details.

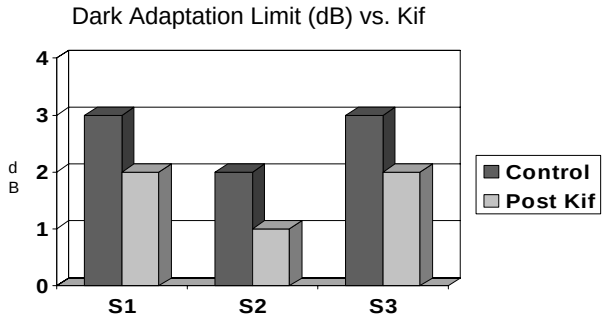


Fig. 7. Dark Adaptation Limit (dB) before and after cannabis smoking. A decrement of 1 dB is noted in each subject after smoking *kif*. This result would be distinctly unlikely due to chance. See text for details.

able to perceive the stimulus at the lowest instrument setting on the Dark Adaptation Test, irrespective of employed dosage (Fig. 5), creating a "basement" effect, beyond which pharmacological benefit from Marinol could not be demonstrated. In contrast, on the Scotopic Sensitivity Test (Fig. 6), no changes were noted until a decrement in sensitivity was observed at 10 mg, and maintained at 20 mg of oral THC, suggesting a dose-response effect. No differences in values were noted in the open control or 0 mg THC dosing sessions from those obtained in a previous "dry run," representing a "test–retest" paradigm. Similarly, the stability of the scotopic sensitivity prior to and following the administration of the 10 mg dose speaks to the temporal test–retest reliability of the measure. No differences in Snellen Chart visual acuity were measured at any dose of THC.

Results of the field trials in Morocco (Figs. 7–8) demonstrated consistent improvements in Dark Adaptation and Scotopic Sensitivity Tests, in each measure and in each subject, after smoking *kif*. Normal subjects vary between each other modestly (0–5 dB), but vary negligibly within the same subject in repeated trials (0 dB in 90% of normal subjects, 1 dB in 10% of normal subjects) (Abbott-Johnson et al., 2002). Hence, variability of 1 dB within the same subject is uncommon. Results of the three-subject Moroccan field trial indicate that each of the subjects perceived the stimulus at

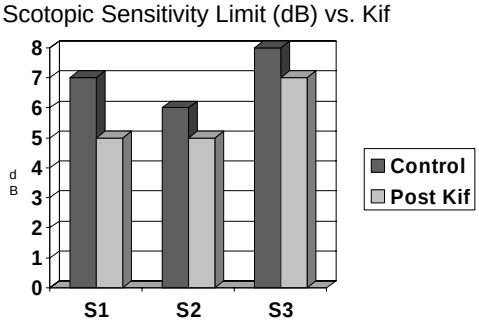


Fig. 8. Scotopic Sensitivity Limit (dB) before and after cannabis smoking. A decrement of 1 dB is noted in two subjects and 2 dB in a third subject after smoking *kif*. This result is statistically significant ($P < 0.05$). See text for details.

1 dB lower setting after administration of *kif* on the Dark Adaptation Test (Fig. 7).

Normal short-term fluctuation in Scotopic Sensitivity is $0.67 \pm 0.32$ (Glovinsky et al., 1992). Using the Scotopic Sensitivity Test in the three-subject Moroccan field trial, a change of 1 dB or greater was obtained (Fig. 8). A $\chi^2$-analysis to compare these obtained results, against three results which would randomly be expected to demonstrate $<-1$, 0, or $>+1$ dB changes in Scotopic Sensitivity, yields a significant coefficient ($\chi^2 = 6.0$, d.f. $= 2$, $P < 0.05$). Once again, no improvement nor decrement in Snellen chart visual acuity was noted in this test paradigm.

## 4. Discussion

Although this is a case study, we believe that these results reasonably indicate support of the hypothesis that oral THC and smoked cannabis may improve night vision sufficiently to merit additional investigation. Furthermore, this pharmacological effect appears to be cannabinoid-mediated. In the Jamaican study (West, 1991), it was hypothesized that non-psychoactive cannabis components were responsible for the putative improvement in night vision, and that the sites of action were the adrenoreceptors of the ciliary epithelium. Previous experiments (Weil et al., 1968; Brown et al., 1977) refute a mere pupillary dilation effect of cannabis. Given the marked paucity of cannabinoid type-1 ($CB_1$) receptors in the striate cortex of Brodmann's area 17 (Glass et al., 1997) and its relative greater abundance in the human retina (Straiker et al., 1999; Yazulla et al., 1999; Porcella et al., 2000), the latter seems the more logical site of mediation of this improvement in night vision. Specifically, the scotopic benefit in night vision would support a stimulatory effect on visual rods. Straiker et al. (1999) have demonstrated a rich $CB_1$ expression in rod spherules, and a modulation of voltage-gaited L-type $Ca^{++}$ channels in the axon terminals of retinal bipolar cells, with the suggestion that cannabinoids modulate glutamatergic synaptic transmission. This neuromodulatory effect was further supported by the identification of the endocannabinoid, 2-arachidonyl glycerol (2-AG), in the retina. In analogous fashion, another group (Bisogno et al., 1999) has demonstrated the biosynthesis and inactivation of the endocannabinoid arachidonylethanolamide (anandamide) in bovine retina, providing further support for the concept that this system may fulfills a neuromodulatory role in scotopic sensitivity.

There may be practical applications for these findings in clinical ophthalmology beyond improvement in night vision or treatment of nyctalopia (night blindness). An interesting anecdotal phenomenon of improvement in visual acuity in retinitis pigmentosa (RP) after smoking cannabis was recently published (Arnold, 1998), but seemed to be strain-specific with respect to the cannabis employed. Further study will hopefully be achieved employing standardized oro-mucosal or vaporized cannabis extracts (Whittle

et al., 2001) in a totally objective double-blind experiment in normal and RP patients utilizing electroretinography (ERG) to assess this hypothetical application, and whether significant therapeutic benefits are possible at a dosage that is not subjectively too intoxicating to the subjects. In this manner, the relative contributions of THC, CBD, other cannabinoids, and even essential oil terpenoid components (McPartland and Russo, 2001), to the observed effects, could be scrutinized and quantified.

The neuroprotective and antioxidant effects of THC and CBD (Hampson et al., 1998) may have additional applications in other eye diseases such as senile macular degeneration, or in the vascular retinopathy of glaucoma (Jarvinen et al., 2002), where similar claims for therapeutic clinical cannabis are abundant.

## 5. Conclusions

The current study supports the previous ethnobotanical observations that cannabis may improve night vision. This effect seems to be dose-dependent and cannabinoid-mediated. Further study may reveal whether this clinical application of cannabis could be added to treatment of pain, spasticity of multiple sclerosis, and nausea of chemotherapy as recognized indications for this ancient substance.

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