



BULLETIN ON NARCOTICS

CR-Sent
01-26-89 MFI

for 1985

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cannabis

UNITED NATIONS

DIVISION OF NARCOTIC DRUGS
Vienna

**BULLETIN
ON
NARCOTICS**

**Volume XXXVII, No. 4
October—December 1985**

Special issue on cannabis

**119740-
119748**

**U.S. Department of Justice
National Institute of Justice**

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**UNITED NATIONS
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Critique of a study on ganja in Jamaica

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ABSTRACT

In the study of "Ganja in Jamaica" by Rubin and Comitas, no significant differences between heavy ganja smokers and controls could be demonstrated in physical and psychological symptoms or social adjustment. This lack of difference may be attributed to methodological limitations in the sampling technique and examinations performed. The number of subjects studied was small (30 in both control and test group). The selection of controls was inadequate; only 12 controls had never smoked ganja, and 8 were current occasional users. Methodological limitations flawed the physical examinations of the lung and cardiovascular system, cytogenetic studies, psychological assessment and psychiatric evaluation. Acceptance by the authors of a positive motivational influence of cannabis smoking and other socially beneficial properties of such smoking was based more on philosophical premises than on objective observations performed by others in Jamaica and other countries.

Introduction

In 1971, the Center for Studies of Drug Abuse of the National Institute on Mental Health contracted the Research Institute for the Study of Man, New York, to conduct a study of the effects of chronic cannabis smoking in Jamaica. V. Rubin and L. Comitas, specialists in anthropology and professors at the Teachers College of Columbia University, New York, undertook the study in co-operation with the Faculty of Medicine, University of the West Indies, Jamaica, and published its results in 1975 under the title "Ganja in Jamaica, a Medical Anthropological Study of Chronic Marijuana Use" [1]. As the conclusions of this study have had a considerable influence on cannabis control policy in Jamaica and elsewhere, this article is written in an effort to provide a critical appraisal of the study, which has never been so far made.

Historical background

Cannabis was brought to Jamaica in 1845 by indentured labourers from India, who called it ganja, as they did in their native land. The habit spread first among the lowest socio-economic classes. Eventually, numerous reports attributing episodes of insanity to ganja smoking aroused public concern, and in 1913 the Government banned cultivation and import of the plant. Despite those measures, the use of the drug spread, which prompted the enactment of more severe legislation in 1924. During the late 1930s a cult arose whose members were called "Rastafarians". They believed that ganja was a holy plant, and smoking it was part of their religion. These cultists popularized ganja smoking, particularly in the form of the "spliff", a four-inch cigar made of a mixture of ganja and tobacco. In 1941, the Government again increased the penalty for ganja smoking and its legislation became the harshest in the world against cannabis.

During the years following the Second World War, the problem of ganja remained a public concern and both the Government and the mass media strongly condemned its use. During the 1960s, civil disorder fuelled an attitude that associated ganja smoking with criminality. As officials became aware that ganja had become a cash crop instead of one grown only for domestic consumption, laws were further strengthened in 1961, the year before Jamaica gained its independence. In the period following independence, the ganja problem remained a concern because domestic use, as well as illegal export, continued to increase.

In 1972, the national authorities in Jamaica adopted a more liberal attitude towards dealing with the problem of ganja smoking, which was similar to the approaches emerging in the United Kingdom of Great Britain and Northern Ireland and the United States of America. One of the first legislative actions taken by the authorities in Jamaica was to introduce a bill abolishing mandatory sentencing for ganja offences. Passage of the bill was facilitated by the results of the study. The study, which essentially exonerated ganja from causing any damaging effects on mind, body and society that had previously been attributed to the drug, was used to bolster the arguments of Jamaican authorities for more lenient laws.

Since the elimination of mandatory sentencing for cannabis offenders ganja trafficking has flourished. During the late 1970s the export of agricultural products from Jamaica stagnated, while the illicit exports of cannabis, mainly to the United States, reached a high level, making this drug the major cash crop of the country. Currently it is a billion-dollar enterprise. Small farmers depend for survival on its cultivation and sale, and the scions of some of Jamaica's well-known families have become marijuana entrepreneurs. The burgeoning marijuana traffic poses many problems for the future of Jamaican society. The situation is similar in other countries, such as Colombia, Morocco and Lebanon, where cannabis is illegally produced by

semi-literate farmers who scrape a bare existence from growing and selling it while affluent entrepreneurs derive handsome profits from its trade, thus fostering an illegal enterprise that becomes a major source of corruption.

The use of the study to justify a change in marijuana law in Jamaica demonstrates the impact of the study on Jamaican policy. The conclusions of the study also had repercussions on the marijuana debate in other countries. It provided compelling arguments for those who advocated a policy of decriminalization and social acceptance of marijuana use. In the United States, for example, *Consumers Report* in 1975 relied heavily on the study in describing the medical effects of cannabis [2]; its findings were favourably echoed in the *New York Times* [3] and the *San Francisco Chronicle* [4]; a review of the study in *Science* indicated that it was "the most significant set of findings on cannabis ever assembled in a single study" [5]. Such prestigious lay and scientific publications reinforced the opinion of the American public that marijuana use was not particularly hazardous to health. Following the publication of the report on the study [1], pro-marijuana organizations in the United States such as the National Organization for the Repeal of Marijuana Laws intensified their lobbying efforts for decriminalization. The report on the study was also widely circulated in Western Europe for the same purpose.

Although there has been widespread acceptance of the report on the study, it has never been critically appraised. Many physicians and scientists, including the author of this article, believe that the conclusions of the study are not justified, even by its own data. In addition, the medical part of the report on the study was fraught with basic methodological errors and major omissions in the selection of the sample of subjects and in the analysis of both their performance on the tests and the recorded data. The social scientists who directed the study identified with the plight of destitute farmers whose ganja use formed part of a life-style which did not seem at the time to be seriously detrimental either to themselves or to their community.

The report on the study was divided into the following three parts: an ethnological study of the importance of ganja in Jamaican society; clinical studies of ganja users; and socio-cultural generalizations concerning the use of ganja. The methodology adopted and conclusions reached are described and critically analysed below.

Ethnological study

Seven communities, one urban and six rural, were chosen for the study. Results from only two of the rural communities were described in the final report.

In one rural community, a group of 178 men over 15 years of age representing different social classes was studied. One half of them admitted

having smoked ganja at one time or another, but the investigators did not specify the amount or potency of the drug consumed either by "occasional smokers" who took it three or four times a week or by "chance smokers" who took a draw when offered. Of those who smoked ganja, 50 per cent used one or more ounces of the drug daily ([1], p. 48). Of the 178 men in the group studied, 47 were either former smokers or "unclassifiable". Among the ganja smokers, the majority were from the lowest social class. Out of 20 from the upper social class four were occasional users.

Since the use of ganja was so pervasive in the communities studied, it was not possible to find enough non-ganja smokers who could constitute a control group. Of the 36 men who reported to have been non-smokers, 11 were from the upper social class.

The most frequent method of marijuana use was the spliff, which was preferred to the "chillum", a large pipe shared by several users. The method of smoking was similar to that reported elsewhere: one "inhales deeply, holds the smoke as long as possible and exhales slowly" ([1], p. 47). Other ganja preparations were also used. For example, ganja tea, made with ganja leaves and sticks with sugar and milk added, was used by 48 per cent of the households surveyed. Usually prepared by the women, ganja tea was frequently given to children in the belief that it would improve the functioning of the brain. Ganja tea drinkers were not usually smokers. Ganja tonics, concoctions of green or dried plant material mixed with rum or wine, were popular as multi-purpose medicine, which were often used daily. Such preparations were also recommended for soothing troublesome infants and children. The investigators did not measure the content of tetrahydrocannabinol (THC) and other cannabinoids of those preparations, nor was their frequency of use established among ganja smokers or non-smokers.

Ganja use in depressed socio-economic classes began in infancy with the introduction of ganja tea and tonics. Actual smoking began in adolescence, especially in households where fathers were regular smokers. Boys began smoking as early as 10 years of age and became habitual smokers when they earned their living. Adolescents smoked ganja in relatively large groups dominated by youthful vendors. Smoking ganja was seen as a kind of rite of passage, an audacious act, signifying the transition from adolescence to maturity. Patterns from occasional to steady use were thus established, but information about them did not include any data concerning sex distribution, relative frequency of use, impact on school attendance, learning, occupation or social mobility ([1], p. 53).

Cultivation of ganja

As a result of widespread use of ganja in the community, consumers who were also farmers devoted part of their time both to the cultivation and distribution of ganja. Out of 153, 39 "identifiable" households in the

community studied were occupied with the cultivation of ganja, but in fact, there might have been many more. Of them, 22 grew ganja for personal use and 17 for outside distribution. All but five households belonged to the lowest social segment of the population. The largest commercial planters cultivated 100 to 200 roots, whereas personal users planted approximately 10 roots. One root yielded three pounds of marketable ganja, which was worth \$20 to \$60. Such figures were inadequate for determining the amounts of ganja produced in the community either for local consumption or for outside sale. The report stated: "... none of the ganja cultivators relies exclusively on this production for a livelihood ... For the great majority, it is an inseparable ingredient of the ganja complex style of life, as well as a source of additional income. Cultivation of ganja is a poor man's enterprise" ([1], p. 42).

Ganja grew like a weed and required special care only during the first three weeks after planting. Although two crops a year were possible, most farmers planted one. After reaping, ganja was left in the fields for several months to dry in the sun, a process which is called "curing". Because ganja is illegal, cultivation was done in secret by individuals. This was unusual for Jamaican farmers who generally worked in "reciprocal partnership" ([1], p. 43). Each grower of ganja not only did all the work, but also took all the profit of a cash crop which, unlike others had a stable price structure. Only "... the largest planter in the community ... employs several adolescent boys to weed ganja fields, and pays them not in cash but with ganja" ([1], p. 43).

A major problem of the small ganja grower was protecting himself against theft, especially when his crop lay in the field for curing. There was obviously no recourse to the law. Unless ordered to do so, however, local police rarely disrupted ganja cultivation. An East Indian observer in the community described the situation: "... poor Afro-Jamaicans fight among themselves, report each other to the police and steal from each other's ganja plots" ([1], p. 45).

In contrast to the haphazard cultivation described above was an example of a family enterprise from another parish. Related males worked together, cultivated several acres, organized close watches over their crops, and maintained elaborate warning systems against police raids. With the rising demand for ganja export, such systems were more efficient and common.

The ganja trade

The distribution of ganja in the community was described as "a small business activity of a large number of occasional and part-time vendors" ([1], p. 45) and as "another supplementary enterprise available to the poor" ([1],

p. 46). Among the 178 men covered by the study, 16 sold ganja in the community, in addition to the five commercial producers. All 16 vendors were also consumers, and 12 of them cultivated ganja on a small scale and sold it in small quantities to trusted clients, friends and acquaintances. Those part-time vendors combined selling of ganja with other work, although for some, dealing in ganja might have provided the major part of their income. Such dealers belonged to the lowest economic group; they had families and stable households. Although inactive in church and community organizations, with the exception of two "bad boys" out of 16, they were "nice guys, jocular and inoffensive" ([1], p. 46). Two of the vendors catered exclusively to the young. One of them offered a free supply and "invites boys to share a *chillum* . . . he has gained control of almost all the smoking sessions of the young" ([1], p. 47).

Besides those who sold ganja to only 10 or 20 regular clients, there were large-scale distributors who served between 50 and 100 people and held "herb camps or yards", gathering places where clients could find, in addition to ganja, liquor and other amenities such as television sets or record players ([1], p. 52).

To describe the ganja trade, Rubin and Comitas depended primarily on anecdotal reports. These reports were no substitute for data such as the amount of ganja transacted, number and frequency of transactions, money involved and mode of payment. Such information was unavailable and so were detailed surveys of the village topography, land tenure, production cycles, labour and its distribution, and size and price of different crops in relation to ganja.

During the course of their study, the investigators found no evidence suggesting the existence of local or national organizations seeking to control the cultivation and distribution of ganja, although Jamaica had already become a major exporter of this drug both to the United Kingdom and the United States. The smuggling of ganja in exchange for money and arms was soon to follow, ending with the billion dollar illegal ganja enterprise of the 1980s. Nothing in the report on the study foresaw such an outcome.

Ganja use and farming

A community that was typical for the area of the Blue Mountains was studied. The community consisted of 85 households and approximately 70 per cent of its land was under cultivation ([1], p. 64). The investigators concluded that "no firm conclusion can be drawn concerning the relationship between land exploitation patterns and smoking ganja" ([1], p. 79). In ten households, none of the owners were heavy ganja smokers,

while three were light to moderate smokers ([1], p. 78), and land was cultivated to capacity by the owner: in six households, the owners were able to hire labourers and in one the owner was a dealer for whom others did most of the work. For 27 households, available lands were only partially cultivated: in 20 households, the farmers were either sick, too old, or pursued other occupations, while in three households they were alcoholics and in four heavy ganja smokers. In the remaining 48 households, which possessed limited land holdings, seven were headed by heavy ganja smokers, four of whom preferred odd jobs to farming.

From these figures, heavy ganja smoking, like alcoholism, appeared to be not conducive to efficient land exploitation. The authors of the report did not draw this same conclusion however, because "these are correlative conditions" ([1], p. 78).

Ganja production and food requirements

The investigators examined four volunteers using special equipment to measure the energy requirements and amount of motion expended during work periods. The results indicated that, when under the influence of ganja, the volunteers expended 50 to 60 per cent more calories, made more useless limb motions and took up to twice as long to cultivate their fields than they would have taken had they not smoked ganja. The farmers claimed that smoking ganja inspired them to work harder and made them feel stronger. Although ganja smoking actually diminished productivity, nonetheless the field-hand not only felt good but had the impression that he was working more effectively ([1], p. 70).

The increased energy expenditure associated with the recorded decrease in productivity had to be compensated for by a parallel increase in food intake. The report stated "figures for average food consumption indicate that men in the community, smokers and non smokers, eat enough to meet their energy requirements", but added in a footnote: "data for women and children indicate that the health of the adult males is maintained at considerable nutritional expense to other household members" ([1], p. 77). Where food was in short supply, the entire community suffered when ganja-smoking farmers were less productive and ate up to twice as much food as non-smokers in order to meet their caloric output. Rubin and Comitas, however, did not point out that negative effect on the livelihood of the community. Their opinion was that the decrease of total cultivated area was helpful because it "limits the disruptive effects of competition for scarce resources and market outlets and [maintains] social cohesiveness among farmers" ([1], p. 79).

Ganja use and the "motivational syndrome"

"The conviction that ganja is beneficial is universally held by the using population in Jamaica and is fundamental to the belief that supports the ganja complex" ([1], p. 55). "Most respondents associated the use of ganja with clear thinking, meditation and concentration, ... and self-assertiveness" ([1], p. 56). Subjects claimed that ganja developed their sense of responsibility, helped them learn a trade, solve problems, design furniture, and discover the truth. "Informants categorically stated that ganja ... enabled them to work harder, faster and longer" ([1], p. 56). Thus, "in all Jamaican settings observed, the workers are motivated to carry out difficult tasks with no decrease in heavy physical exertion, and their perception of increased output is a significant factor in bolstering their motivation to work" ([1], p. 79).

In their chapter entitled "Acute effects of ganja smoking in a natural setting", Rubin and Comitas indicated that heavy marijuana smoking decreased the amount of work performed while it increased energy expenditure. As a result there was a decrease in productivity ([1], p. 75). They minimized their quantitative data, in claiming that the decrease in work performance was actually beneficial to the farmers because ganja use "supports the status quo, psychologically as well as structurally" ([1], p. 150). The researchers appeared to attach more weight to the perceived redeeming effects of ganja smoking, as expressed by the users, than they did to the actual data they collected in the field.

In another report [6], Comitas claimed that cannabis smokers cut as much sugar-cane as did non-smokers, and thereby contradicted his earlier findings. In the latter study, however, there were no data concerning the amount or frequency of ganja smoked and no figures for energy consumption of the two groups. Comitas concluded that "heavy cannabis use does not adversely affect productivity". It is a fact, nevertheless, that Jamaican production of sugar has declined rapidly in the decade following the study.

From a psychopharmacological point of view, the "motivational syndrome" observed by Comitas can be attributed to drug-oriented behaviour and drug dependence. Users need the drug to "motivate" them to perform their daily tasks. Chopra in India and Soueif in Egypt reported similar behaviour. Chopra stated: "Laborers who have to do hard physical work use cannabis to alleviate the sense of fatigue. Cannabis induces mild stimulation that enables the worker to bear the strain and monotony of daily life". Unlike Rubin and Comitas, Chopra did not believe in a "motivational" effect of the drug. According to his observations, cannabis use actually leads to mental and physical deterioration [7-9]. In his study comparing 850 cannabis users to 839 controls, Soueif concluded "that the work capacity of the hashish users is significantly impaired as to quality and

quantity" [10]. Soueif also noted that when the users were deprived of the drug, they worked in an erratic fashion. The life of a chronic cannabis user became centred around the drug which gave him a primary reward unattainable by other means. Under its influence he submitted willingly to the drudgery of menial tasks. In Jamaica, landowners have exploited the workers' craving for ganja by paying part of their wages with the drug.

Clinical studies of ganja users

The sample

Two "matched" groups of 30 ganja smokers and 30 controls recruited from the communities surveyed made up the sample selected for clinical studies. Aged between 23 and 53 with the average age of 34 years, they all belonged to the lower income group and had completed four to five years of school. Controls were more likely to have held some skilled jobs and were less likely to have suffered unemployment. Six of the smokers, or 20 per cent of the sample, were ganja vendors. Eight of the smokers, or 26 per cent of the sample, were Rastafarians, who constituted 2 to 3 per cent of the Jamaican population. The authors recognized that "the sample is non random and . . . no statistical claim is made as to its representativeness of the total population" ([1], p. 181).

The smoking of ganja was so prevalent in the lower classes that only 12 subjects in the non-smoking control group were able to assert that they had never smoked cannabis. Of the non-smokers 18 had in the past smoked ganja, and eight of them admitted to being current occasional users (two or three times a week) ([1], p. 115). Furthermore, Rubin and Comitas admitted that the controls might also have used the commonly consumed ganja-containing teas or tonics, but "information on this subject was not collected from them" ([1], p. 84). There is no certainty that any of the controls was completely cannabis-free.

Another problem was how to determine the actual amount of cannabis smoked and for what duration. Some smokers claimed to have smoked a minimum of three spliffs a day for 10 years ([1], p. 81). "After entering the hospital for study, two smokers admitted that they had smoked for seven years only" ([1], p. 81), and one in the group of heavy smokers in reality smoked only a few times a week ([1], p. 115). The average years of smoking was 17.5. The age at onset of regular use ranged from 7 to 37 years with the average age at 15. The authors stated that "an early experience with ganja may be considered predictive of later use" ([1], p. 83).

Smokers were divided into three groups: low users with four or less spliffs a day; moderate users with five to eight spliffs; and heavy users with more than eight spliffs. Ganja smokers who smoked a pipe consumed from 1 to 25 pipeloads per week. Smokers also drank ganja tea and tonics. There

was no attempt at quantifying the amount of daily use in terms of grams of cannabis and THC equivalent. Such a quantification would have been difficult, since a "spliff may contain anywhere from two to six grams of cannabis" ([1], p. 46). The content of samples given to the researchers for analysis varied from 0.7 to 10.5 per cent with a mean of 2.8 per cent of THC. The smokers were, therefore, exposed to a wide range of THC concentration. In this respect, the smokers lacked homogeneity, as was true of the control group.

Throughout the study, no "significant differences" between smokers and controls could be demonstrated. The reason for this lack of difference was due to the limited number of subjects studied and to the lack of proper controls.

Ganja and tobacco were mixed together in the spliff, but the relative proportions of one to the other were not given. Twenty-seven ganja smokers also smoked tobacco versus 19 controls. The exact amount of tobacco consumption was not mentioned. Both groups drank alcohol, but the ganja smokers tended to drink less than the non-smokers; here again, there was no quantification of the amount consumed by either group.

Aside from ganja, tobacco and alcohol, the subjects did not consume any other addictive drugs. As stated by the authors, "amphetamines and barbiturates are virtually unknown among working class Jamaicans who rely on folk medicines and have limited access to costly prescription or patent medicine" ([1], p. 164). A small amount of heroin abuse observed in Jamaica involved tourists. Thus the addictive drugs popular in North America were not available in Jamaica. Yet Rubin and Comitas used the Jamaican example to indicate that, with the exception of alcohol and tobacco, cannabis use was not associated with the use of other psychoactive drugs.

The subjects spent a week at the Kingston University Hospital to undergo a variety of clinical tests. Physical examination showed that one smoker had a long history of bronchial asthma, a condition which was known to be worsened by the effects of cannabis smoking [11, 12]. Rubin and Comitas stated however, "There is nothing to suggest that this disability was in any way related to ganja" ([1], p. 85).

On the average, smokers weighed seven pounds less than the controls. Other routine clinical examinations, tests, and lung X-rays showed that the subjects were within normal limits while a significant proportion (30 per cent) of both smokers and controls showed anomalies in their electrocardiogram results.

Pulmonary function

Forced vital capacity was a test performed on both smokers and controls to measure the maximum column of air expelled from the lungs at

full capacity during a forced expiration. Forced expiratory volume was performed to measure the volume of air expired from the lungs during the first one-second period of forced expiration, and peak flow rate to measure the expiratory performance of the lung in litres per minute. On all tests, twice as many smokers as non-smokers had a lowered capacity.

The investigators failed to determine whether the impaired lung functions were related to dose and duration of exposure to ganja. They did not separate the ganja smokers according to light, moderate or heavy use, nor did they take into account the height and weight of individual subjects. Results of the smoker group were compared with those of non-smokers and a third group of occasional smokers who had been recruited from non-smoking groups.

Additional available data indicated that the ganja smokers, including occasional users, had impaired pulmonary gas exchanges. They presented lowered partial pressure of O₂ in arterial blood (hypoxia) to be associated with lowered partial pressure of CO₂(pCO₂) (as a result of hyperventilation) and increased haemoglobin content of the blood.

Because the ganja smokers also used tobacco either separately or mixed with ganja, Rubin and Comitas attributed the findings indicating the impairment of lung function to "smoking *per se*". However, those heavy ganja smokers who chain-smoked spliffs could hardly smoke much in the way of tobacco in a pure form, and no evaluation was made of the comparative amounts of ganja and tobacco used in the mixtures inhaled by the smokers.

Despite disclaimers to the contrary, data collected by Rubin and Comitas indicated that cannabis smoking damaged pulmonary function, but their method of analysis prevented them from reaching such a conclusion. The investigators might have used the methods of Tashkin and others [11] whose study of a group of marijuana smokers, given the drug in a controlled environment, showed lung impairment. These authors used conventional scientific methods and quantified their data. They found that heavy marijuana smoking induced a dose-related decrease in the forced expiratory volume, which showed an increased resistance to air flow [11]. Their findings supersede those of Rubin and Comitas who, on the basis of incomplete data analysis, asserted that even heavy ganja use was not associated with any significant impairment of lung function.

Other tests

The psychiatric evaluation, the electroencephalogram (EEG) examination and psychological assessments did not indicate any consistent difference between cannabis smokers and non-smokers, neither did cytogenetic studies.

The psychiatric evaluation indicated that ten smokers and two non-smokers reported past hallucinations. It was not stated whether or not the two non-smokers belonged to the occasional smokers group who had been mixed with the controls. This information is important since 50 per cent of the hallucinations were experienced when the subjects smoked for the first time. The families of eight of the smokers and two of the non-smokers had a history of mental illness and seven of the smokers and three of the non-smokers had a family history of alcoholism. One smoker was hospitalized for a schizophrenic-type illness, perhaps provoked by heavy ganja use, and one non-smoker had a personal history of past mental illness. In view of the long association between cannabis use and mental illness reported in Jamaica and elsewhere, the foregoing points should have been explored further. Native Jamaican psychiatrists have reported instances of psychoses induced by heavy ganja use, for example, F. Knight, whose observations were made at the time the report by Rubin and Comitas was released [13].

The EEG examination showed that 14 of the smokers and nine of the control group had low voltage tracings, and five of the smokers (16 per cent) and three of the control (10 per cent) had abnormal tracings. Such results indicated that the entire sample selected fell outside the norm of a healthy population. The authors did not indicate whether or not the low-voltage EEG or abnormal tracings in non-smokers were observed in occasional users. Again the authors failed to consider a possible dose-effect relationship in analyzing their data.

Data resulting from the psychological assessment tests indicated that "long-term cannabis use did not produce demonstrable intellectual or ability deficits" ([1], p. 118). Other studies ([10] and [14]), in which the criteria for cannabis use and abstention were stricter and tests were performed on larger samples, did not agree with such a conclusion. Furthermore, conventional psychological tests are often inadequate in determining deficits in performance which in real life are, nonetheless, apparent to the clinical observer.

Cytogenetic studies did not show any significant differences in chromosomal anomalies between smokers and controls. However, these studies were flawed with methodological problems: nearly half of the cell cultures did not grow and the number of cells examined in metaphase in each preparation was too limited for proper statistical evaluation. More recent controlled studies by Morishima and others [15] on chronic heavy marijuana users indicate that while cannabis derivatives are not clastogens, they are mitotic disrupters (induce chromosome segregational errors).

Basically, Rubin and Comitas attributed to smoking *per se* rather than to heavy ganja use many of the physical symptoms observed among the individuals studied. In coming to this conclusion, the investigators ignored many of the available studies that had documented the damaging effects of cannabis on cell metabolism and cell division. Rubin and Comitas put forward the thesis that ganja played an important, even redeeming role in

Jamaica. Ganja was "extraordinarily well integrated into working-class life-styles. Ganja serves multiple purposes that are pragmatic rather than psychedelic! Working-class users smoke ganja to support rational task-oriented behavior, to keep conscious, fortify health, maintain peer group relations and enhance religious and philosophical contemplation. They express social rather than hedonistic motivations for smoking . . . Ganja as an energizer is the primary motivation given for continued use . . . In fact, the ganja complex provides an adaptive mechanism by which many Jamaicans cope with limited life chances in a harsh environment" ([1], p. 166).

A dissenter to the view of Rubin and Comitas is J. Hall, Chairman of the Department of Medicine at Kingston Hospital. Studying ganja users for many years, he observed [16] that:

"An emphysema-bronchitis syndrome, common among Indian laborers of the past generation who were well-known for their ganja smoking habits, is now a well-established present day finding among black male laborers in Jamaica . . .

"Ganja has long been regarded both by the laity and the profession as a cause of psychosis in Jamaica. The unrivalled accumulated experience of Cooke, Royes, and Williams, who were in recent years senior medical officers at Bellevue Hospital in Kingston, Jamaica, fully substantiate this . . .

"An incidence of 20% impotence among males who have smoked ganja for five or more years was reported by me earlier . . .

"Personality changes among ganja smokers and members of the Rastafari cult are a matter of common observation in Jamaica. The apathy, the retreat from reality, the incapacity or unwillingness for sustained concentration, and the lifetime of drifting are best summed up in the 'amotivational syndrome' of McGlothlin and West."

Hall concludes,

"The study of Rubin and Comitas does not have the general support of experienced clinicians and other workers in the field. We believe that the selection with which the study was done was faulty and that, in regard to the reported absence of any change in the chromosome pattern, their technique was faulty, and that certainly as regards the statement that there was no respiratory effect, it is unfounded" [17].

The scientific and medical studies that have been performed on chronic cannabis users since the report by Rubin and Comitas was released concur with Hall's clinical observations [18 - 22].

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Alteration of glucose metabolism in liver by acute administration of cannabis

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ABSTRACT

In previous research on the effects of cannabis on cellular functions the authors observed an increase in glucose metabolism in the post-mitochondrial fraction of the liver of rats submitted to chronic administration of cannabis extracts. Continuing this research on rats submitted to acute cannabis intoxication a single dose of cannabis extract (600 mg/kg) in olive oil is administered to male adult rats and the animals are killed within a 36-hour period. The analyses show that energetic and detoxifying metabolism of glucose is increased, as indicated by the increase of F-1, 6-di P-aldolase and uridin-diphosphoglucose-dehydrogenase activities, which parallels the observed decrease of glycogen levels. Maximum effect appears between 8 and 16 hours after administration.

Introduction

In previous research on the effects of cannabis on the cell the authors observed that the administration of the active resin to rats produced a strong impairment of hepatic glycogen, which was not related to any modification of intracellular or extra-cellular glucose [1].

In recent studies designed to elucidate the possible alteration of glucose metabolism the authors have shown [2] that both acute and chronic administration of cannabis mobilizes the intracellular stores of glycogen in liver, thus agreeing with the results of other authors [3, 4]. The maintenance of normal levels of serum and liver glucose was explained by a strong increase in both energetic and detoxicating glucose metabolism. The results of the authors' research on the evolution of these biochemical parameters in rats submitted to acute cannabis intoxication are summarized in this article. The authors have also attempted to clarify the contradictory results, such as hypoglycaemia [5, 6], hyperglycaemia [7] and diabetic coma [8], reported by different investigations in relation to serum glucose levels in both animals and humans.

Materials and methods

Having extracted cannabis plant material with petroleum ether (boiling point 40°—60°C), cannabinoid content was estimated and the residue was dissolved in olive oil for administration to animals. One hundred adult male Wistar rats, weighing 150—200 grams, were caged in groups of three. Food and water were available *ad libitum*.

A single 600 mg/kg dose was injected into 58 rats subcutaneously and the animals were killed by decapitation 4, 8, 12, 16, 20, 24 and 36 hours after the administration of the drug, and blood and liver samples were taken for analysis. Samples from control groups of untreated animals (26 rats) and animals (16 rats) treated with olive oil were also analysed.

Liver samples were homogenized in 5 volumes of 0.25 sucrose-10 mM hepes and post-mitochondrial fraction (pmf) was obtained after 30 minutes centrifugation at 18,000 rev/min [9]. Glucose was determined in serum and pmf of the liver by the glucose-oxidase method [10]. Glycogen was determined after alkaline digestion of liver by the anthrone reaction according to Seifter [11]. Fructose-1, 6-di P-aldolase was determined in liver pmf by a coupled enzymatic assay [12]. Uridin-diphosphoglucose-dehydrogenase (UDPG-DH) was determined in liver pmf in accordance with Gayney and Phelps [13]. Protein concentration was estimated by the Lowry method [14].

Results

There was no significant modification of glucose levels in either serum or liver at almost any time of the acute intoxication (see table 1), but serum glucose decreased by 40 per cent; eight hours after the administration of cannabis, from the mean value found in control animals, while liver glucose increased by 27.2 per cent four hours after the administration of cannabis and then returned to a normal level. Liver glycogen considerably decreased 4 hours after the administration of cannabis and after 20 hours it showed a slight restoration.

Table 2 shows that the enzymatic activities of F-1, 6-di P-aldolase and UDPG-DH increased. F-1, 6-di P-aldolase showed a maximum induction 12 hours after the administration of cannabis. UDPG-DH increased strongly, but the increase oscillated considerably.

Discussion and conclusions

The study of the evolution of different parameters and enzymatic activities related to glucose metabolism in liver after the administration of a single dose of cannabis to rats confirmed the results that the authors had previously found in chronically intoxicated rats. The first action of cannabis

Table 1
Serum and liver glucose and glycogen levels in rats submitted to acute cannabis intoxication

Group	Time ^a (hours)	Glucose				Glycogen liver	
		Serum		Liver		μg/mg	Percentage
		mg/ml	Per-	mg/ml	Per-		
A. Experimental group of animals that received cannabis (600 mg/kg)	4	0.97±0.03	91.5	2.43±0.23	127.2	55.60±10.30	46.4
	8	0.64±0.23	60.4	2.07±0.05	108.4	61.00±1.98	50.9
	12	0.96±0.07	90.6	2.02±0.55	105.7	67.48±22.50	56.3
	16	1.08±0.26	101.9	1.85±0.18	96.8	64.60±2.46	53.9
	20	0.96±0.24	90.6	2.04±0.30	106.1	94.09±12.17	78.5
	24 ^b	1.04±0.19	98.1	1.75±0.54	91.6	82.48±9.29	68.8
	36	1.02±0.12	96.2	1.80±0.04	94.2	—	—
B. Control ^c	—	1.06±0.06	100.0	1.91±0.17	100.0	119.86±36.63	100.0
C. Control ^d	—	1.06±0.01	100.0	1.89±0.07	98.9	123.14±18.18	102.7

^a Time between cannabis administration and death of animals; mean values for six animals.

^b Mean values for 22 animals.

^c Mean values for 26 untreated animals.

^d Mean values for 16 animals treated with olive oil and killed 24 hours after the administration of olive oil.

Table 2
F-1, 6-di P-aldolase and UDPG-DH activities in livers of rats submitted to the acute cannabis intoxication

Group	Time ^a (hours)	F-1, 6-di P-aldolase ^b	Per-	UDPG-DH ^b	Per-
A. Experimental group of animals that received cannabis (600 mg/kg)	4	58.50±0.50	117.8	2.18±0.23	125.0
	8	58.73±15.08	118.3	3.25±0.18	187.9
	12	63.24±6.68	127.4	—	—
	16	61.15±2.49	123.2	2.29±0.33	132.2
	20	52.54±6.12	105.8	2.66±0.41	153.7
	24 ^c	45.33±14.50	91.3	3.62±0.72	209.2
	36	45.77±7.62	92.2	3.14±0.24	181.5
B. Control ^d	—	49.64±11.28	100.0	1.73±0.49	100.0
C. Control ^e	—	51.22±9.03	103.2	1.65±0.27	95.3

^a Time between cannabis administration and death of animals; mean values for six animals.

^b Activities expressed as nmol. NAD/mg protein/min.

^c Mean values for 22 animals.

^d Mean values for 26 untreated animals.

^e Mean values for 16 animals treated with olive oil and killed 24 hours after the administration of olive oil.

on the hepatic cell seemed to be the mobilization of glycogen stores. The released glucose was quickly metabolized as shown by the increase in both the energetic metabolism (F-1, 6-di P-aldolase) and the detoxicating metabolism (UDPG-DH). Thus the glucose was consumed at the same rate as it was released from glycogen, which explained why no major oscillation could be observed in serum or liver glucose levels. The alteration of those levels was only observed early in the acute intoxication; 4 hours after the administration of cannabis, glucose increased in liver, probably due to a delay in the induction process of the enzymatic systems.

Nearly eight hours after the administration of cannabis, the strong increment of glucose metabolism produced a transient hypoglycaemia, which was then quickly restored, because 12 hours after the administration of cannabis blood sugar values were normalized. This fluctuation explains the contradiction in the reported results of other authors, because the blood sugar level changes according to the intoxication time at which the experiment has been carried out. These findings are in agreement with the observation by Pasquale and others [7] concerning dogs subjected to a single dose of tetrahydrocannabinol.

According to F-1, 6-di P-aldolase values, the maximum effect upon the energetic metabolism of glucose took place 12 hours after the administration of cannabis and was re-established after 20 hours, whereas the detoxicating mechanism (UDPG-DH) remained higher after 24 hours, coinciding with low glycogen levels.

The foregoing findings indicate that cannabis increases the energetic requirements of the cell. It also mobilizes the enzymatic system which are necessary for its own metabolism; these actions occur at the expense of intracellular stores of glycogen. It is also recognized that an important effect of cannabis is the inhibition of the synthesis of nucleic acids and proteins [15]. Consequently, the enzymatic systems must be inhibited as well. The fact that with glucose metabolism just the opposite is observed suggests that this must be a specific effect. It would also confirm the opinion of Luthra and Rosenkrantz [16] concerning the observed decrease in macromolecules as a result of other biomolecules, besides sugars and polysaccharides, functioning as energetic substrates.

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