

Joseph Manno,¹ Ph.D.; Barbara Manno,² Ph.D.; David Walsworth,³ B.S.; and Ray Herd,⁴ M.S.

Analysis and Interpretation of the Cannabinolic Content of Confiscated Marihuana Samples

In the last decade marihuana consumption in the United States has increased dramatically. A recent government estimate suggested that sufficient illicit marihuana is available in this country to provide 10 cigarettes per capita. Criminal penalties for possession of marihuana in this country are assigned for possession of defined quantities of marihuana and its identification as *Cannabis sativa* by microscopic and/or chemical tests.

Marihuana contains several dozen structurally similar compounds with the same chemical nucleus and these are generally termed "cannabinoids." Of the cannabinoids in marihuana, three are generally present in the high concentrations (greater than 0.1 percent by weight). These are Δ^9 -tetrahydrocannabinol (THC), cannabidiol (CBD), and cannabinol (CBN). It has been established that the pharmacologic activity of marihuana is due primarily to THC [1]. In a recent comparison between intravenously administered THC, CBD, and CBN, Perez-Reyez et al [2] established that CBN and CBD could produce effects similar to those of THC, but that 10 times more CBN and 14 times more CBD had to be administered. Clinical investigations have demonstrated that the effects of marihuana are just perceived when one marihuana cigarette containing 0.25 percent THC is smoked. Decrements in motor and mental performance have been produced in individuals smoking marihuana containing between 1 and 2 percent THC [3-5]. Based on our experience with the administration of marihuana cigarettes to humans, a concentration of THC in marihuana from 0.5 to 1.5 percent can be considered "good" quality marihuana. If the concentration of THC is less than 0.5 percent, the marihuana would be poorer quality and cigarettes with a concentration of THC in excess of 1.5 percent would be very good to excellent marihuana [3-5].

In recent years, several reports have been published from laboratories which analyzed samples of marihuana from sources around the world in an attempt to define different types of marihuana based on the concentrations of the cannabinoids THC, CBN, and CBD. As anticipated, there was wide variation in the concentrations of these chemicals, with THC content ranging from 0 to 8 percent by weight [6-12]. Others [9,11] have

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¹Associate professor, Department of Pharmacology and Therapeutics, Louisiana State University Medical Center, Shreveport, La.

²Pharmacologist, General Medical Research, Veterans Administration Hospital and associate professor, Department of Pharmacology and Therapeutics, Louisiana State University Medical Center, Shreveport, La.

³Medical student, Louisiana State University Medical School, Shreveport, La.

⁴Director, Northwest Criminology Laboratory, Shreveport, La.

grown marihuana seed obtained from various countries under controlled conditions in order to test what effects climate, soil, temperature, and other local conditions would have on the concentrations of the various cannabinoids. This research established that the concentration of THC in marihuana is not dependent on local growing conditions, but on the seed from which it is grown. In other words, seed from marihuana that contains high concentration of THC will produce marihuana with high THC concentration, no matter where it is grown. It was also observed that THC will eventually decompose to CBN and that the original amount of THC present in marihuana can be computed by adding the amount of CBN to the THC present at the time of assay. Fetterman et al [9] have reported that there are two separate chemical phenotypes of marihuana, depending on the concentrations of CBD and THC. Based on the relationship of concentrations of THC and CBD, they have established a formula to define this phenotype as $\% \text{ THC} + \% \text{ CBN}$ divided by $\% \text{ CBD}$. In this way they relate the $\% \text{ THC}$ originally present to the $\% \text{ CBD}$ present. Plants that have a high THC content and a low cannabidiol content would have a phenotype ratio greater than one [1] and are considered "drug" type marihuana. Those that have a high cannabidiol content and a low THC content will have a phenotype ratio less than one [1] and are considered "fiber" type marihuana. Small and Beckstead [11], in a similar study, found that plants that are drug phenotype generally originate from countries south of latitude 30 deg N. Plants that are fiber phenotype originate north of the same latitude.

By assaying marihuana for its content of THC, CBD, and CBN, a great deal of information can be obtained regarding the potential source of the sample, its potency as a drug, and the approximate time since it was first processed. It would also follow that if many confiscated samples had the same concentrations of THC, CBD, and CBN, they would likely come from the same source, which could then be sought as a distribution point.

Over the past six years we have had the opportunity to perform quantitative assays of marihuana samples obtained from confiscated material supplied by the police or brought by individuals for identification. We have not kept records of the assays, but have noted that the concentrations of THC seem to be increasing. In order to get some idea of the "quality" of marihuana available in Shreveport, La. during the last three years, we performed quantitative assays on samples of marihuana confiscated during 1971, 1972, and 1973. The samples were randomly selected and supplied by the Northwest Criminology Laboratory.

Materials and Methods

Gas Chromatography

Equipment included a Beckman GC 65 gas chromatograph equipped with a flame ionization detector, in conjunction with a Leeds and Northrup Speedomax XL 600 Series recorder and a Disc integrator with automatic printer. A silanized glass column 1.5 m by 6 mm outer diameter by 2 mm inner diameter was packed with 3 percent OV-17 on Chromasorb W-HP 100-120 mesh and operated at 250°F. Injector and detector temperatures were maintained at 275°F. We have also used a column coated with 1 percent OV-1 and 1 percent OV-17 on Chromasorb W acid washed and DMCS treated 100-120 mesh, and have obtained similar results when it was operated under the same conditions as the 3 percent OV-17 column. Helium was used as carrier gas at 90 ml/min, hydrogen flow was 60 ml/min, and air was supplied at the rate of 300 ml/min.

Extraction

All samples were carefully weighed and placed in a Soxhlet extractor and extracted with chloroform until the extract was colorless (2 to 4 h). The extraction was

concentrated to 25 ml in a volumetric flask and 5 μ l aliquots were injected into the gas chromatograph for analysis. Our previous experience has been that extraction is complete when the chloroform in the Soxhlet extractor is clear.

Results and Discussion

A typical chromatogram from a marihuana extract is shown in Fig. 1. The identity of the cannabinoids cannabidiol, Δ^9 -tetrahydrocannabinol, and cannabinol were established from standards. Quantitation was based on the area of the peak as determined by the Disc integrator and printer.

The results from our analyses are represented in Tables 1-4. The data are represented as percent-by-weight concentrations of CBD, THC, CBN, and THC + CBN. Because much of the THC had decomposed to CBN before we gained access to the samples, our discussion will refer to the % (THC + CBN) in order to relate to the marihuana sample when it was fresh. We feel that this will also provide a more suitable criteria for comparing samples taken over a three-year period. For the year 1971, the majority (87 percent) of marihuana confiscated was drug-type marihuana and most of it was in the

TABLE 1—*Marihuana confiscated in 1971 (31 samples).*

Cannabidiol, %	Δ^9 -THC, %	Cannabinol, %	THC + CBN, %	Phenotype Ratio
0.028	0.832	0.018	0.850	30.0
0.036	0.338	0.309	0.647	17.0
0.168	0.279	0.564	0.843	5.0
0.016	0.109	0.175	0.284	17.0
0.108	0.159	0.307	0.466	4.3
1.180	0.265	0.041	0.306	0.2
0.146	0.215	0.357	0.572	3.9
0.090	0.163	0.252	0.415	4.6
0.106	0.042	0.397	0.439	4.1
0.039	0.341	0.317	0.658	16.0
0.101	0.188	0.405	0.593	5.8
0.034	0.308	0.303	0.611	17.0
0.820	0.158	0.150	0.308	0.3
0.033	0.068	0.136	0.204	6.1
0.039	0.380	0.388	0.768	19.0
0.040	0.412	0.400	0.812	20.0
0.036	0.322	0.289	0.611	16.0
0.039	0.402	0.327	0.729	18.0
0.038	0.382	0.321	0.703	18.0
0.139	0.242	0.554	0.796	5.7
0.034	0.487	0.486	0.973	28.0
0.076	0.173	0.568	0.741	9.7
1.210	0.044	0.029	0.073	0.1
0.071	0.151	0.277	0.428	6.0
0.038	0.315	0.337	0.652	17.0
1.100	0.074	0.110	0.184	0.2
0.070	0.305	0.604	0.909	12.0
0.038	0.439	0.347	0.786	20.0
0.108	0.200	0.516	0.716	6.6
0.048	0.364	0.422	0.786	16.0
0.052	0.286	0.284	0.570	10.0
\bar{X}	0.196	0.272	0.594	
σ	0.346	0.157	0.156	

range from 0.5 to 1.5 percent that would be considered "good" marihuana. The highest concentration of any samples was 0.909 percent. In 1972 the mean value for THC + CBN increased slightly but the quality of individual samples fell, with the majority of samples (59 percent) containing less than 0.5 percent THC + CBN. In 1973 there was a

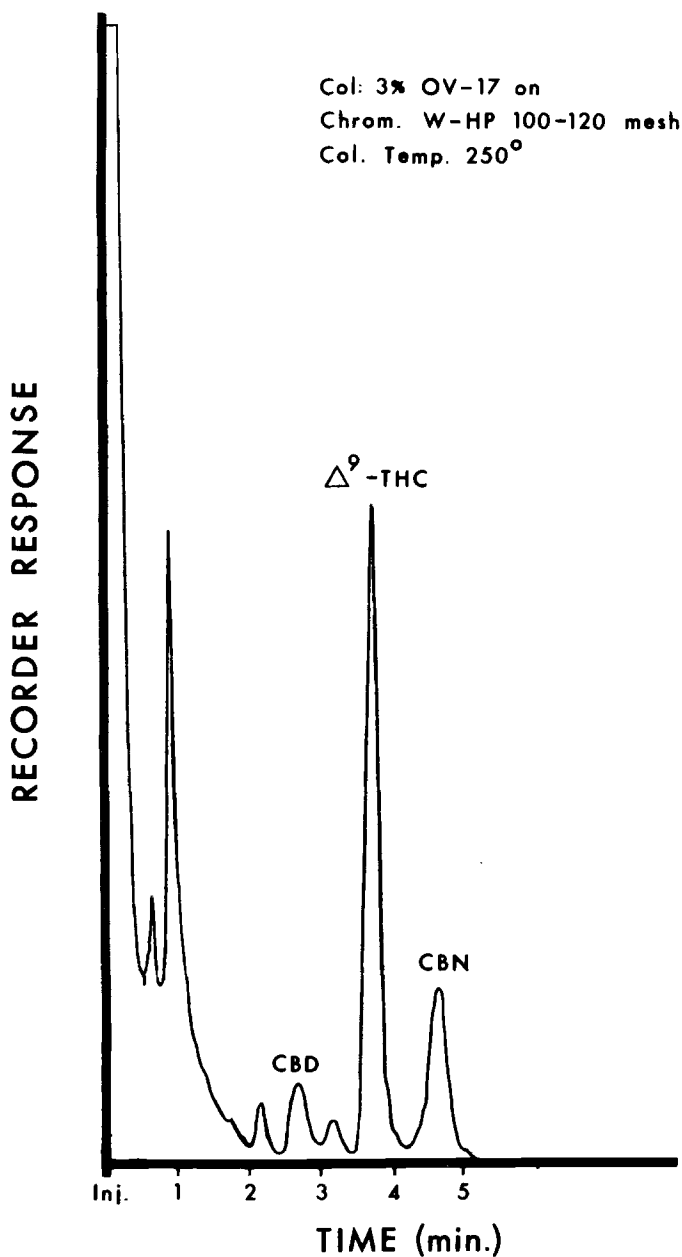


FIG. 1—Gas chromatographic tracing of marijuana extract. Δ^9 -THC represents Δ^9 -tetrahydrocannabinol, CBD represents cannabidiol, and CBN represents cannabinol.

TABLE 2—*Marihuana confiscated in 1972 (36 samples).*

	Cannabidiol, %	Δ^9 -THC, %	Cannabinol, %	THC + CBN, %	Phenotype Ratio
	0.038	0.120	0.126	0.246	6.4
	0.029	0.640	0.116	0.756	26.0
	0.082	0.313	0.432	0.745	9.0
	0.094	0.140	0.233	0.373	3.9
	0.363	0.220	0.143	0.363	1.0
	0.017	0.070	0.097	0.167	9.8
	0.008	0.070	0.092	0.162	20.0
	0.000	0.080	0.129	0.209	
	0.014	0.074	0.104	0.178	12.0
	0.017	0.092	0.107	0.199	11.0
	0.012	0.070	0.081	0.151	12.0
	0.013	0.087	0.136	0.223	17.0
	0.016	0.075	0.103	0.178	11.0
	0.013	0.065	0.089	0.154	11.0
	0.009	0.044	0.052	0.096	10.0
	0.017	0.148	0.104	0.252	14.0
	0.028	0.129	0.144	0.273	9.7
	0.025	0.088	0.118	0.206	8.2
	0.030	0.119	0.155	0.274	9.1
	0.058	0.361	0.260	0.621	10.0
	0.036	0.168	0.140	0.308	8.5
	0.137	0.355	0.412	0.767	5.5
	0.105	0.483	0.576	1.059	10.0
	0.537	0.033	0.027	0.060	0.1
	2.040	0.531	0.109	0.640	0.3
	0.099	0.889	0.284	1.173	11.0
	0.050	1.420	0.373	1.793	35.0
	0.096	0.179	0.319	0.498	5:1
	0.078	0.206	0.280	0.486	6.2
	0.149	1.530	0.300	1.830	12.0
	0.188	1.600	0.290	1.890	10.0
	0.157	0.235	0.384	0.619	3.9
	0.196	1.870	0.479	2.349	11.0
	0.124	0.569	0.544	1.113	8.9
	0.183	0.608	0.366	0.974	5.2
	0.121	1.270	0.105	1.375	11.0
\bar{X}	0.148	0.415	0.217	0.616	
σ	0.342	0.498	0.145	0.587	

dramatic increase in the quality of the marihuana samples. The mean for all samples increased to 1.080 percent. The majority of samples were in the 0.5 to 1.5 percent range and fully 24 percent had concentrations of THC + CBN greater than 1.5 percent, the highest being 2.451 percent.

It can be seen that the overall trend in the Shreveport area is toward increasing "quality" of marihuana. Of the three years sampled, 1972 was the worst year, with the greatest percentage of samples being in the less than 0.5 percent category. There was a dramatic increase in the overall quality of marihuana in 1973, with an almost twofold increase in the concentration of THC + CBN from the two previous years. The percent samples above 1.5 percent concentration increased from 0 percent in 1971 to 12 percent in 1972 and finally to 24 percent of total in 1973.

TABLE 3—*Marihuana confiscated in 1973 (32 samples).*

Cannabidiol, %	Δ^9 -THC, %	Cannabinol, %	THC + CBN, %	Phenotype Ratio
0.025	0.404	0.016	0.420	16.0
0.064	0.623	0.310	0.933	1.4
0.066	0.940	0.054	0.994	15.0
0.104	2.110	0.095	2.205	21.0
0.063	1.050	0.121	1.171	18.0
0.122	0.860	0.092	0.952	7.8
0.139	1.180	0.240	1.420	10.0
0.015	0.193	0.008	0.208	13.0
0.048	0.150	0.000	0.150	3.1
0.103	0.103	0.000	0.103	1.0
0.335	0.160	0.000	0.160	0.4
0.007	0.740	0.087	0.827	118.0
0.061	2.240	0.211	2.451	40.0
0.114	0.933	0.158	1.091	9.5
0.049	1.326	0.093	1.419	28.0
0.090	0.010	0.000	0.010	0.1
0.075	0.450	0.038	0.488	6.5
0.126	0.639	0.095	0.734	5.8
0.072	1.010	0.188	1.198	16.0
0.776	0.920	0.080	1.000	1.2
0.198	1.040	0.137	1.177	5.9
0.146	1.024	0.089	1.113	7.6
0.144	1.700	0.165	1.865	12.0
0.153	1.210	0.074	1.284	8.3
0.245	0.165	0.076	0.241	0.9
0.221	1.870	0.323	2.193	9.9
0.191	1.040	0.079	1.119	5.8
nil	1.600	0.283	1.883	
nil	0.971	0.149	1.120	
nil	1.260	0.056	1.316	
nil	1.620	0.059	1.679	
nil	1.340	0.296	1.636	
\bar{X}	0.135	0.965	0.131	1.080
σ	0.143	0.578	0.088	0.637

We would also like to point out the relationship between the amount of CBN (decomposition product of THC) and the total THC + CBN content. In 1971 CBN accounted for 54 percent, in 1972 CBN accounted for 35 percent, and in 1973 CBN represented only 12 percent of total THC + CBN.

It is apparent that the marihuana available in Shreveport is of reasonably good quality. Based on the low concentrations of CBN in the 1973 samples, the delay between harvesting and distribution for general consumption also is not too long. Although some of the samples are very weak in terms of potency, some attention must be given to the increasing percentage of samples that contain concentrations of THC greater than 1.5 percent. It is in this range that smoking marihuana can produce decrements in an individual's ability to perform tasks requiring concentration, coordination, and judgment.

Summary

Confiscated marihuana samples from a three-year period were assayed quantitatively for their concentrations of Δ^9 -tetrahydrocannabinol (THC), cannabidiol (CBD), and

TABLE 4—*Marihuana* confiscated in 1971, 1972, and 1973.

Phenotype	No. of Samples (%)	Concentration of THC + CBN, ^a %	No. of Samples (%)
1971			
Drug	27 (87)	0.0-0.5	5 (19)
Fiber	4 (13)	0.5-1.5	22 (81)
		1.5 +	0
1972			
Drug	34 (94)	0.0-0.5	20 (59)
Fiber	2 (6)	0.5-1.5	10 (29)
		1.5 +	4 (12)
1973			
Drug	29 (94)	0.0-0.5	5 (17)
Fiber	3 (6)	0.5-1.5	17 (59)
		1.5 +	7 (24)

^aOnly drug-type marihuana included.

cannabinol (CBN) by gas chromatography. A wide variability in the concentrations of the cannabinoids was observed and a steady increase in potency of the samples was evident in the more recently confiscated specimens. The concentration of THC, CBN, and CBD and their ratios can be used to relate the approximate age of the sample (time from harvest), the potential source of the marihuana, and its potency. The relationships and their significance are discussed.

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