

## A Survey and Comparison of Heroin Seizures in Israel During 1992 by Fourier Transform Infrared Spectrometry

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**ABSTRACT:** During 1992, a survey was performed on heroin powder exhibits seized throughout Israel. The main objectives were to detect salt forms and additives and compare the powders for intelligence and investigation purposes. A total of 3817 exhibits were scanned by FTIR; five major groups were distinguished: heroin free base, heroin base with caffeine, heroin base with paracetamol (acetaminophen), heroin base containing both caffeine and paracetamol, and a mixture of heroin base, heroin HCl and caffeine. In addition, 419 exhibits collected during a two month period were compared amongst themselves and categorized into sub-groups based on the similarity of their spectra. Based on this data, it was possible to define 116 different sub-groups, of which 56 sub-groups contained from 2 to 47 samples. Of the total number of cases tested, 78% were in the weight range 1 mg–1 g, that is, user quantities. Results were tabulated on both a geographical and monthly basis. Differences were found in the distribution of additives between different geographical areas of the country.

**KEYWORDS:** criminalistics, heroin, FTIR, illicit drugs

The first comprehensive annual survey of heroin exhibits seized in Israel was made in 1992. The results were classified according to the weight of the seizure, geographical area and composition of additives. Since the Analytical Laboratory of the Division of Identification and Forensic Science is National, the data gives a comprehensive picture of drug seizures in general and heroin in particular.

Heroin profiling (that is, attempts to carry out comparisons between heroin seizures) has been performed in various laboratories (1,2), primarily using chromatographic methods such as GC or HPLC. In Israel, all heroin exhibits submitted to the laboratory are routinely examined by FTIR. The heroin is classified into two types according to its marketed form: heroin free base and heroin hydrochloride. It is generally accepted that heroin base is smoked, whereas heroin hydrochloride is dissolved in water and injected.

Illicit heroin is only rarely pure; other substances are usually present, including reaction by-products, impurities and various adulterants and diluents. Within the limits of detection of the FTIR, all of these components contribute to the IR spectrum. Each exhibit has its own characteristic spectrum, and comparison between the

different spectra gives a gross estimate of the similarity or dissimilarity between the different exhibits.

Collecting FTIR data provides a basis for various types of data analysis:

1. Obtaining a survey of heroin exhibits throughout the country and in each of its five districts.
2. Supplying the investigators with additional information to determine distribution networks (that is, via common FTIR results).
3. Creating a tool for comparing exhibits from different seizures according to specific requests from investigators. These comparisons, in addition to their investigative value, may sometimes be of assistance in cases where the question of similarity arises in court (for example, to help establish a possible connection between a dealer and a user).

### Experimental

#### Instrumentation

Infrared spectra were obtained using a Laser Precision Analytical RFX-30 FTIR Spectrometer (Irvine, California) with a deuterated triglycerine sulfate (DTGS) detector. Spectra were recorded using 32 scans. A Wilks 12.7 mm (half inch) diameter pellet holder was used to prepare potassium bromide (KBr) pellets using 6350 Kg (seven tons) ram pressure; the sample size was approximately 1–2 mg of powder in approximately 100 mg of KBr.

#### Classification Procedure

Determining the presence of a given compound from the FTIR spectrum of a mixture was based on absorbance occurring at given frequencies characteristic of the compound (see Fig. 1).

The library search system was a commercially available spectral search program called HAVEC (Hardware Augmented Vector Correlation—Laser Precision Analytical, Irvine, California), which uses an algorithm for Euclidean distance for comparison purposes. The unknown spectrum is first converted to an absorbance, baseline corrected form, then normalized and a search performed against the chosen libraries comparing selected, deresolved, spectral regions. A deresolved spectrum consists of 250 data points, whereas a full spectrum consists of 8000 data points. The algorithm is a function of the difference in intensity between the library spectra and the unknown spectrum at a given number of frequencies; the smaller the difference, the closer the match. Upon completion of the library search, the ten closest fits appear on the screen, including the Euclidean distance for each one.

For the year 1992, data were obtained for 3,817 heroin exhibits; each was classified according to its weight and major additives.

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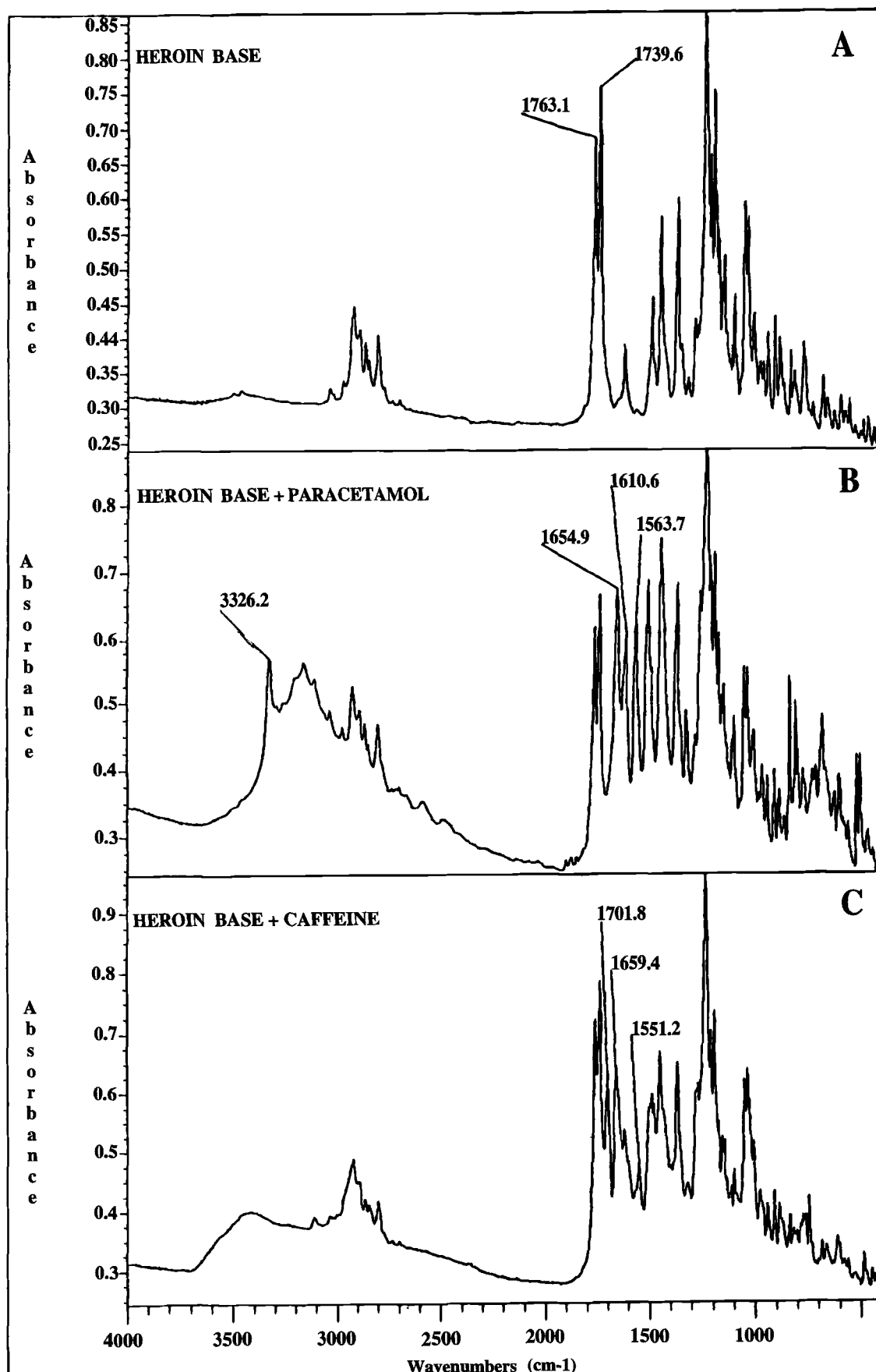


FIG. 1—FTIR spectra of three exhibits: A—heroin base, B—heroin base + paracetamol, C—heroin base + caffeine. The frequencies labeled in the spectra are characteristic of heroin base, paracetamol and caffeine, respectively.

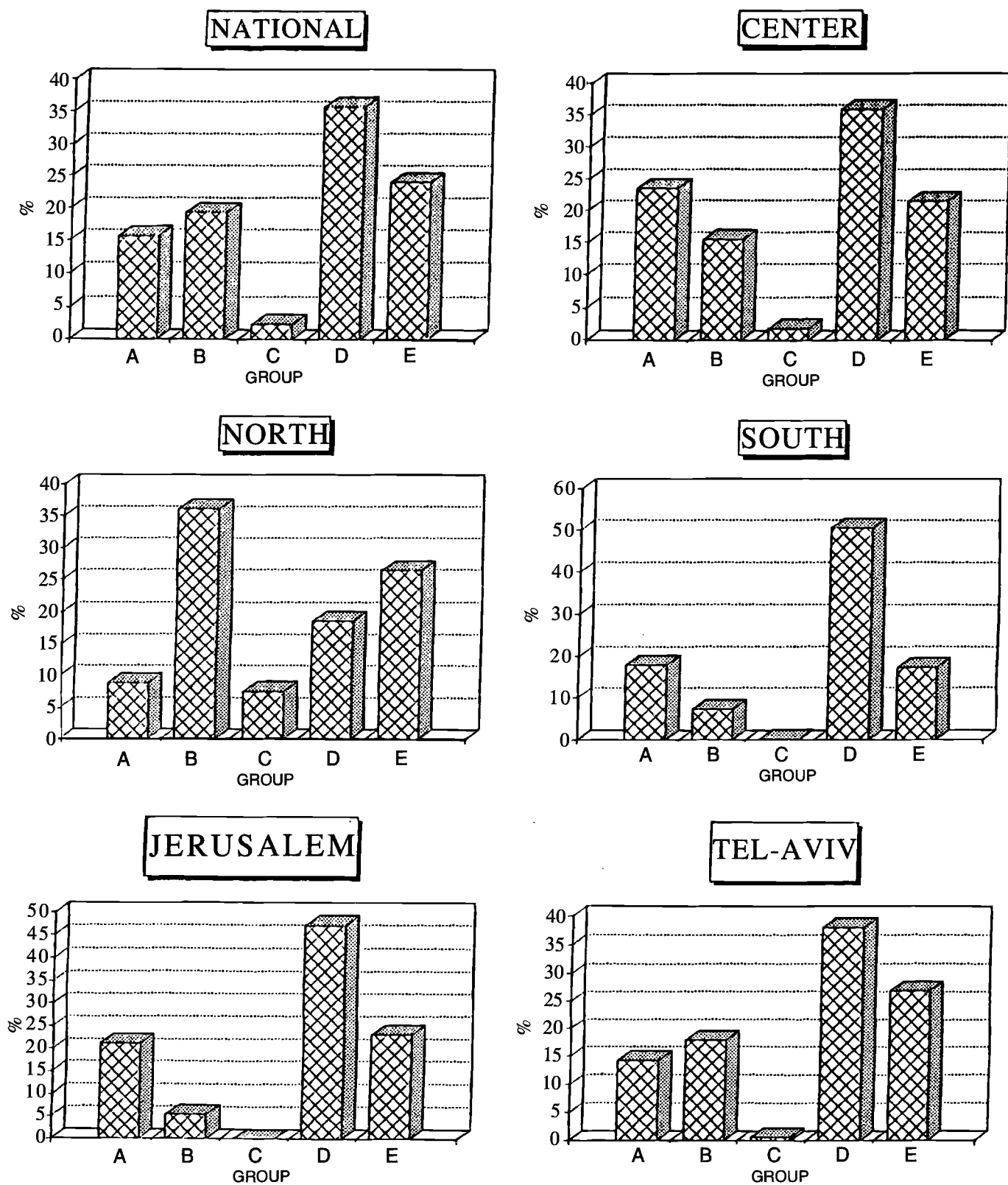


FIG. 2—Heroin profile in a cross section of the five districts in the country and nationwide in the weight range 1 mg–1 g: A—Heroin base “without additives,” B—Heroin base + caffeine, C—Heroin (base + HCl) + caffeine, D—Heroin base + paracetamol, E—Heroin base + caffeine + paracetamol.

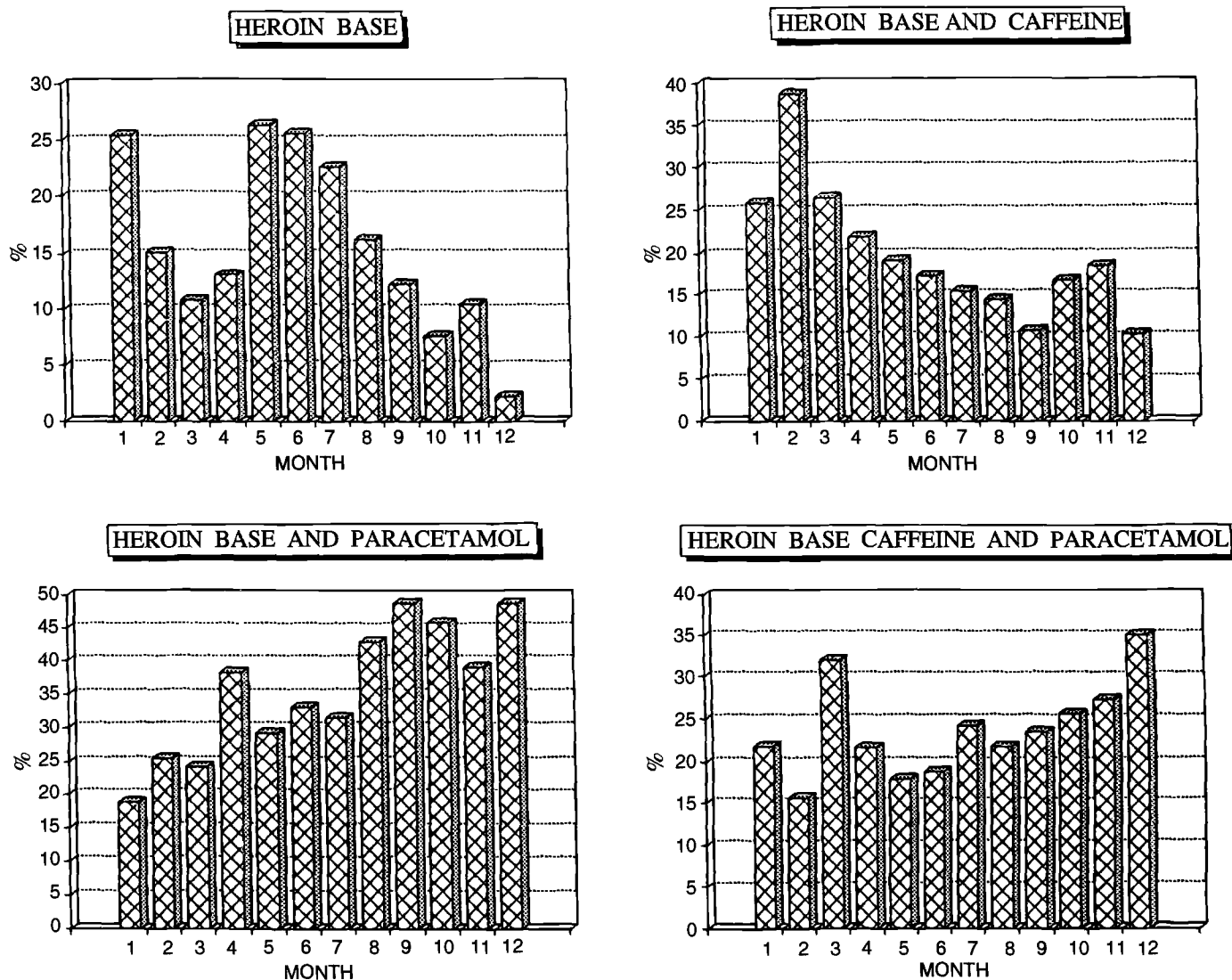


FIG. 3—Fluctuations of the additives on a monthly basis on the national distribution from cases in the weight range 1 mg–1 g.

In addition, during a specific two month interval, the spectra of 419 seizures were internally compared (using HAVEC) to determine Euclidean distances. “Similar exhibits” were defined as: A) when the Euclidean distance did not exceed 0.03; and B) there were no significant visual differences in the spectra.

**Results and Discussion**

The weight distribution of heroin exhibits seized in 1992 is given in Table 1. Most of the seizures were at the user level, that is, 1 mg–1 g; consequently, the data analysis deals only with this weight range. It was found that the most common additives were

caffeine and paracetamol (acetaminophen). Based on major additives, it was possible to distinguish between five major groups (Table 2). An additional group listed as “was not taken into account” consisted primarily of rare or unidentified additives or exhibits with more complex composition.

Of the five major groups, the one defined as “heroin base without additives” means that, within the detection limits of FTIR, no additives were distinguished. In the four other groups, caffeine, paracetamol or both were found. Only one group contained heroin

TABLE 1—Weight distribution of heroin powders seized in 1992.

Weight in grams	Number of cases	Percent
0.001–1	2977	78.0
1–10	665	17.4
10–100	132	3.5
100–250	16	0.4
Over 250	27	0.7
Total	3817	100.0

TABLE 2—Distribution of additives in the weight group range of 1 mg–1 g.

Additives	Number of cases	Percent
Heroin base “without additives”	465	15.6
Heroin base + caffeine	570	19.1
Heroin (base + HCl) + caffeine	72	2.4
Heroin base + paracetamol	1063	35.7
Heroin base + caffeine + paracetamol	716	24.0
not taken into account	91	3.2
Total	2977	100.0

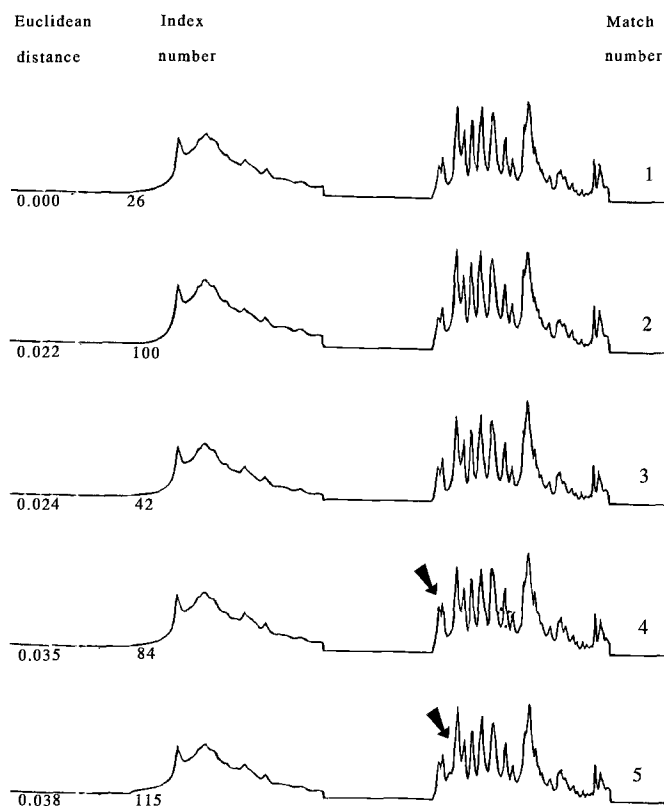


FIG. 4—FTIR library search of a powder exhibit. The first three spectra are considered a sub-group. The Euclidean distance of match number 1 is 0.000 since it is compared against itself. The Euclidean distances of match numbers 4 and 5 are greater than 0.03; the most salient differences observed in the spectra are illustrated by the arrows.

HCl in addition to heroin base. Although procaine was suspected in some cases, it was not taken into account due to the uncertainty and inconsistency in locating characteristic peaks. Impurities were also not taken into account, since they could not be distinguished satisfactorily; however, in some cases, observation of the full spectrum confirmed their presence.

From a total of 2977 seizures in the weight range of 1 mg–1 g only 2.4% contained heroin HCl, in all cases mixed with heroin base and caffeine. In a minor survey performed in Israel in 1988 (3), of 100 heroin exhibits examined over an interval of several months, it was found that 82% contained heroin base, 4% contained heroin base and heroin HCl, and 14% contained heroin HCl. Assuming that both sets of data reflect the actual situation in the country at the time, there appears to be a trend towards a decrease in the use of heroin HCl for injection. Some care must be used in interpreting this data, since drug users are known to convert heroin base into water soluble salts for injection, using organic acids such as citric acid. Nevertheless, it seems safe to assume that the overwhelming majority of addicts in Israel currently use heroin by smoking and not by injection.

Figure 2 illustrates the heroin profile in a cross section of the five districts in the country and nationwide in the weight range 1 mg–1 g. From this cross section, it is clear that the heroin profile in the Northern district is significantly different from both the four other districts and the National profile, in that the percentage of cases containing caffeine is greater than the percentage of cases containing paracetamol. A possible explanation for this unique profile may be the long border of this district with Lebanon. The

profiles in the Jerusalem and Southern districts are very similar, while the profile in the Central district is also generally similar. The profile in the Tel Aviv district is different and closely resembles the National profile. These different profiles may indicate different sources for the drug, that is, different wholesalers working in different districts.

Monthly fluctuations in additives on the national distribution in cases in the weight range 1 mg–1 gram are illustrated in Fig. 3. During the year, there was a general increase in paracetamol and a general decrease in caffeine. The “peak” of heroin “without additives” during the months May–July is probably a seasonal peak. The group consisting of heroin base, heroin HCl and caffeine was not included in this study due to the small number of cases.

During a two month interval, 419 seizures (without any correlation to weight range) were compared amongst themselves for similarity of their spectra. Figure 4 illustrates the results of a library search showing the five closest matches. A total of 116 different sub-groups were defined, from which 56 sub-groups contained at least 2 samples. Most of the sub-groups contained 2–5 samples; however, the two larger sub-groups contained 47 and 32 samples, respectively. Of the 56 sub-groups containing at least 2 samples, 10 of them were from the same geographical region. Most of the sub-groups showed a tendency towards a specific geographical region; however, a minority of the sub-groups, primarily the larger ones, were distributed throughout the country.

From the results of this survey, the main additives in heroin samples in Israel are caffeine and paracetamol, with indications that, during the year, there was an increase in the use of paracetamol and a corresponding decrease in the use of caffeine. Since the data are based only on 1992, it is difficult to ascertain if this is due to chance or is rather a general trend in the Israeli heroin market.

In addition to identifying the drug and its major additives and diluents, there is also an occasional interest in comparing heroin exhibits, primarily for investigative purposes, to determine if there is a possibility that they originate from the same source. Many chromatographic methods (4–10) have been used for this purpose, including thin layer chromatography (TLC), high pressure liquid chromatography (HPLC) and gas chromatography (GC). Due to inherent chromatographic limitations, a combination of at least two methods is generally used before indicating similarity between exhibits.

FTIR also has some discriminating capability to classify powders into a large number of groups, and consequently can be used for gross comparison of heroin exhibits. Some of the advantages of FTIR over chromatographic methods include the ability to distinguish between polymorphs, reduced sample handling and lack of solubility, volatility, thermal stability or column limitations. Major disadvantages of FTIR include drastically lower sensitivity and inability to detect trace components.

## Conclusions

By using FTIR for comparative analyses, a reasonable level of credibility may be obtained to determine gross—level similarities between heroin exhibits. For closely related spectra, this similarity may indicate the possibility of a common source. It should be emphasized, however, that for court purposes, these comparison data alone are *not* sufficient to prove a connection between seizures or the existence of a common source. However, when combined with an appropriate investigation, the data can be very useful, complementary information.

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