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COMPARATIVE GAS CHROMATOGRAPHIC ANALYSIS OF NARCOTICS

II. AMPHETAMINE SULPHATE*

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SUMMARY

Trace impurities in amphetamine sulphate were studied by a highly sensitive gas chromatographic method. The concentration of these impurities varied considerably between batches whereas the variations within the batches were usually very small. The method is used for the assignment of seizures of amphetamine sulphate to common sources, which in turn may permit chains of illicit distribution of this drug to be traced.

INTRODUCTION

In Part III of the series "Minor components of cannabis resin"[1], comparative gas chromatography of minor hashish components was described. The gas chromatograms of these components represent the so-called chemical signatures of hashish. It was found that seizures of hashish giving closely related gas chromatograms could be assigned to common sources. This is of great importance from a forensic point of view, as such assignments can be used to trace back chains of distribution within the illicit drug trade.

In the earlier paper, it was pointed out that comparative gas chromatography could possibly be applied to other narcotics, provided that certain prerequisites are met concerning the number of minor components and the variation of their concentrations within batches (intra-batch variation) as well as between different batches (inter-batch variation). In this investigation, chemical signatures of amphetamine sulphate were studied.

EXPERIMENTAL

Apparatus

The gas chromatograph used was a Perkin-Elmer F11 with a No. 8 analyzer

* The first part of this series[1] concerned hashish.

unit [all-glass single column system with effluent splitter for a flame ionization detector (FID) and an electron capture detector (ECD)], linear temperature programmer, flow control unit and a W + W 1200 double-pen potentiometric recorder.

The column used was a 1.9-m glass tube of O.D. 6 mm (0.25 in.) and I.D. 2 mm with a coil diameter of 130 mm, packed with Gas-Chrom Q (80–100 mesh), coated with 3% OV-17 phenyl methyl silicone. The flow-rate of the carrier gas (nitrogen) was about 35 ml/min, the injector temperature 250°, hydrogen inlet pressure 1.3 atm and air inlet pressure 2.0 atm. The FID:ECD splitting ratio was 1:1, the ECD temperature 260° and the ECD voltage setting 3. Column temperature programme: start at 130°, 0–20 min at 6°/min, 20–26 min at 250°.

Procedure

A 500-mg amount of amphetamine sulphate was placed in a 10-ml graduated glass cylinder provided with a ground-glass stopper. Smaller sample sizes, *e.g.*, 100 mg, were sufficient for materials of low purity (often recognizable by their odour and discoloration). The sample was dissolved in 9 ml of water and 1 ml of benzene was added. The trace components were then extracted by vigorous shaking for 2 min. After separation, most of the benzene layer was transferred into a glass tube with a pipette, leaving about 0.1 ml behind so as to avoid the transfer of any of the aqueous layer. The glass tube (O.D. 7 mm, I.D. 5 mm and 70 mm in length) had a conical shape at the end, giving an I.D. at the bottom of about 2 mm.

The glass tube was then placed in a hot water-bath (60–70°) and the evaporation of benzene was accelerated by suction with a pipette attached to a water pump. In order to avoid deposition of extracted matter on the wall of the tube, the tube was gently shaken three or four times during the evaporation. The suction was stopped when the volume of the extract was 2–4 μl and the concentrated extract was carefully collected with a 10-μl syringe. This procedure was facilitated by the conical shape of the end of the glass tube. The extract was then injected into the gas chromatograph under the conditions mentioned above.

The benzene used was of analytical-reagent grade but had to be re-distilled, discarding the first and last 10% fractions. Graduated cylinders, evaporation tubes, gas pipettes and microsyringes were carefully rinsed with re-distilled benzene before use. In this way, the gas chromatographic peaks obtained from blank samples did not exceed three times the noise level in most instances.

RESULTS AND DISCUSSION

As the present analytical method deals with trace components (parts per million range), large sample sizes were needed. In order to avoid overloading of the column, the trace components were extracted in such a way that most of the amphetamine was left behind in the aqueous layer. The protolysis of the amphetamine sulphate caused sufficient acidity to achieve this effect.

As pointed out in the first part of this series[1], chemical signatures for the assignment of samples to common sources should comprise a high number of peaks so as to keep the probability of coincidental agreements low. Assignments of hashish samples to common sources were based solely on FID signatures because in that case the number of natural minor components sensed by the FID is generally sufficient. As far as

amphetamine sulphate is concerned, the number of trace components visible in the FID signature varies considerably owing to the purity of the sample. This is demonstrated by the upper parts of Figs. 1 and 2, which show the FID signatures of two samples of low and high purity, respectively. Using the FID:ECD double-detector system, a sufficient number of trace component peaks can also be obtained from very pure samples in most instances. The advantage of a gas chromatographic system with double detectors in a related field was demonstrated by Adlard and Matthews[2], who used an FID and a sulphur-selective flame photometric detector in order to obtain chemical signatures of hydrocarbon pollutants.

In order to study intra-batch variations, samples were taken at random from different places within a batch synthesized in the laboratory. The variation obtained was not greater than that observed in repeated analyses of homogeneous solutions of the trace components concerned. The intra-batch variation in seizures of amphetamine sulphate is often greater. Considering the results mentioned above, this is probably due to external contamination rather than lack of homogenity. Fig. 3 demonstrates a comparative analysis of three samples taken at random from a seizure. The uniform distribution of the trace components is not surprising as amphetamine, like other synthetic drugs, is synthesized and purified in liquid media.

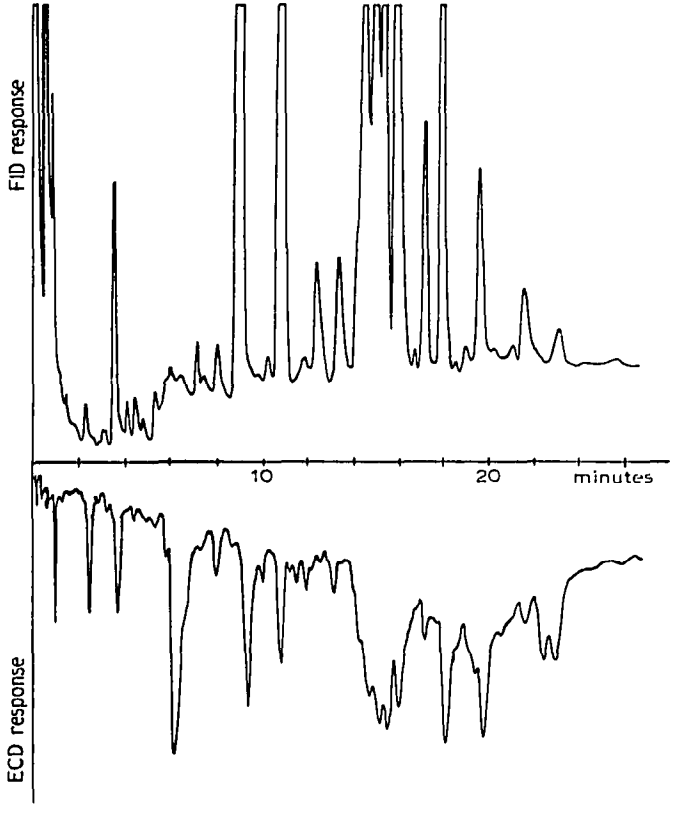

Fig. 1. Signatures of seized amphetamine sulphate of low purity.

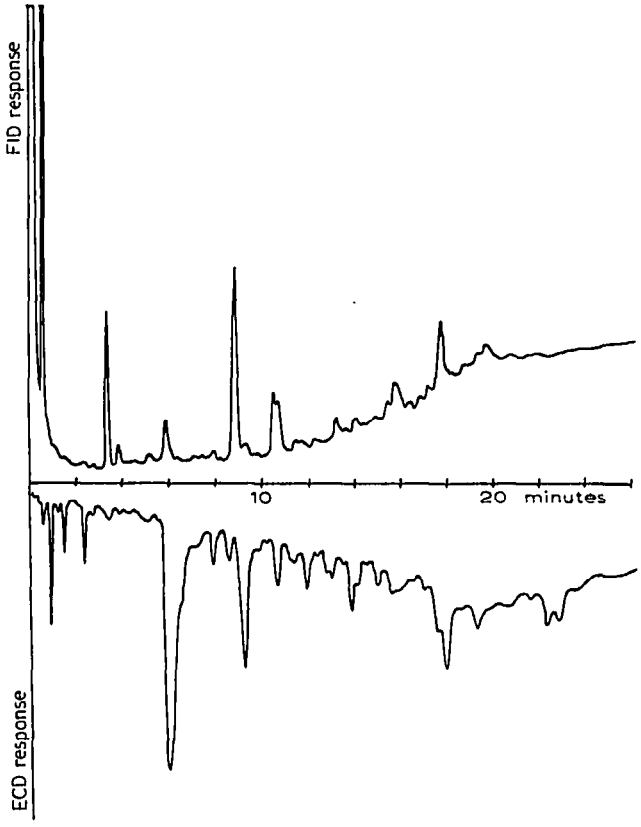

Fig. 2. Signatures of an amphetamine sulphate sample of high purity.

On the other hand, great inter-batch variations were observed when samples of seizures of unknown origin were compared, as seen in Figs. 1 and 2. The question of whether the signature is influenced by the conditions of the synthesis or by the conditions of storage and handling then arises. In order to answer this question, a series of experiments were carried out.

The influence of the method of preparation on the signature was studied in a series of syntheses. Amphetamine was prepared by the three most frequently used methods, *i.e.*, by condensation of phenylacetone with formamide and by reduction of phenylnitropropene electrolytically and with lithium aluminium hydride. As expected, different signatures were obtained. Provided that some of the trace components originate from side-reactions typical of the particular synthesis, the method of preparation can be deduced from the signatures, as the trace components are recognizable not only by their retention times but also by the FID:ECD response ratios. This is another advantage offered by the double-detector system.

A series of repeated syntheses by phenylacetone–formamide condensation was also carried out. These experiments showed a strong influence of several experimental conditions on the signatures. However, good reproducibility was achieved when the starting products were taken from the same batches, the same reaction vessel was

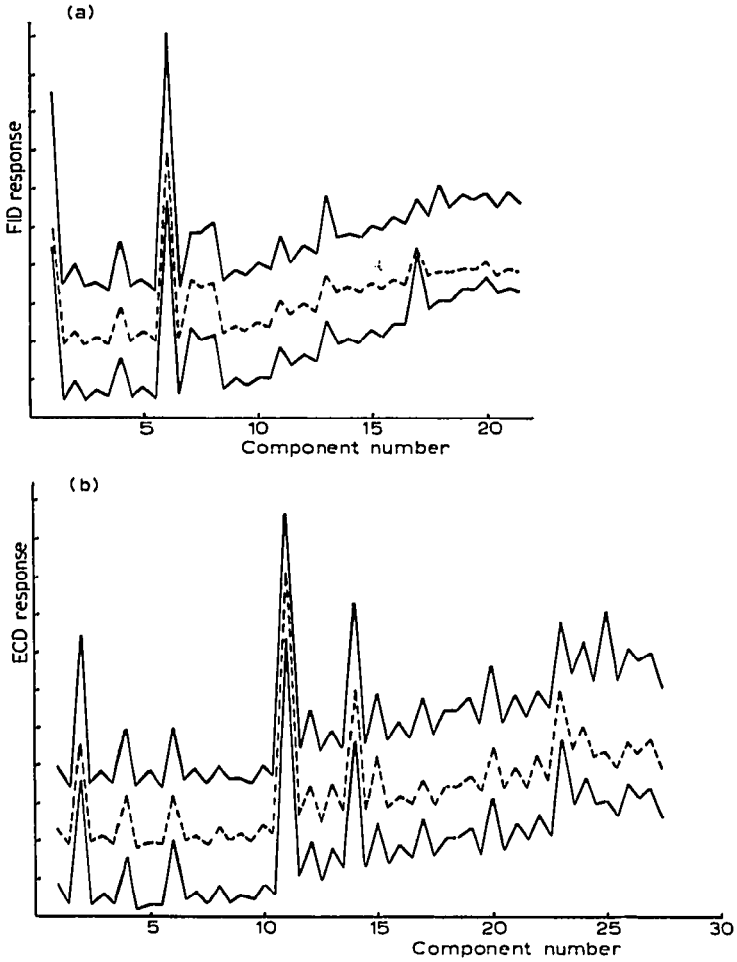

Fig. 3. FID signatures (a) and ECD signatures (b) of three amphetamine sulphate samples taken at random from a seizure. The curves are simplified versions of the original gas chromatograms[1] and are displaced on the ordinate by an arbitrary constant increment. The component numbers in the two diagrams do not correspond to each other.

used and reaction temperatures, reaction times and clean-up procedures were reproduced with extreme care.

The influence of the conditions of storage and handling on the chemical signatures depends on the stability of amphetamine sulphate and of the trace components as well as on the possibilities of external contamination.

Instability of the trace components may cause changes in the signatures with time. However, if two samples show similar signatures, it seems very unlikely that this similarity would result from such changes in samples of originally different composition. On the other hand, if two samples show different signatures, no conclusions can be drawn anyway, as there are many possible explanations for this disagreement, such as inhomogeneity or external contamination. These considerations show that

the possible instability of the trace components does not affect the conclusions drawn from the analyses.

As far as the stability of the amphetamine sulphate itself is concerned, the situation is different. Instability of the main constituent under certain storage conditions may give rise to reaction products that contribute to the original signature and would tend to dominate it increasingly with time. Such a process may thus lead to equalization of originally different signatures. The stability of amphetamine sulphate under various storage conditions was therefore investigated.

Three amphetamine sulphate samples from a homogeneous batch of high purity were stored under helium in closed vials at −20° in darkness, at room temperature (20°) in darkness and at room temperature in daylight (not sunlight). Three more samples from the batch mentioned above were stored under air under the same conditions. After 6 weeks, all six samples showed essentially the same signature as at the start. These results show that amphetamine sulphate is stable under ordinary storage conditions and that the signatures should be unaffected by the processes mentioned for at least 2 months.

The influence of external contamination on the signature was studied to some extent in the laboratory. Preliminary experiments indicated that gelatin capsules may cause serious interference with the FID signature whereas the influence of polyethylene bags was moderate. These experiments were carried out using samples of very high purity and the changes of the original signatures were therefore more pronounced.

Contamination from the surroundings may, of course, also occur if samples are not stored in tightly closed vessels and the signatures may become dominated by this effect. However, conclusions can be drawn from such signatures, provided that they comprise a sufficient number of components. Otherwise, the probability of coincidental agreements cannot be neglected.

CONCLUSION

It has been found that samples of amphetamine sulphate generally contain trace impurities originating from the synthesis. The signatures obtained in this study indicate that the inter-batch variations are much greater than the intra-batch variations. The signatures include retention times and detector response ratios of a high number of trace components. This makes the probability of coincidental agreements very low. Further, originally different signatures should not coincide in time due to processes that occur within the samples under normal storage conditions. The prerequisites for the assignment of samples to common sources are then fulfilled. Therefore, if the signatures of two or more amphetamine sulphate samples coincide, as shown in Fig. 3, for example, they can be assigned to a common source.

Such assignments can conveniently be based on visual comparison of the signatures. The correlation between two signatures can be measured by peak height subtraction[1], *e.g.*, for comparison of intra- and inter-batch variations. Before application of this method, the peak heights should be normalized (highest peak = 100), as all of the benzene extract is not injected into the gas chromatograph.

Comparative analyses of seizures of amphetamine sulphate were started in March 1973 at this laboratory. So far, 54 analyses have been carried out involving

ten cases. In five of these cases, samples could be assigned to common sources. In one case, seven samples from two seizures were subjected to comparative analysis. The signatures of the three samples from the first seizure showed no correlation, whereas one of these samples and three of the samples from the second seizure showed similar signatures, as shown in Fig. 4.

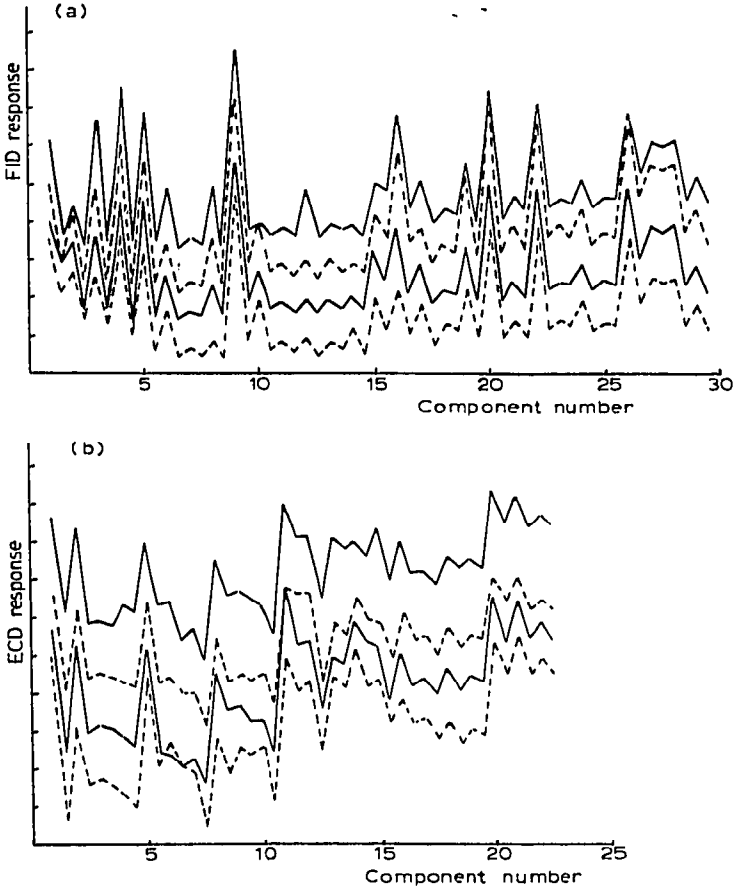

Fig. 4. FID signatures (a) and ECD signatures (b) of four amphetamine sulphate samples from two seizures. The original signatures are simplified as in Fig. 3.

Provided that the prerequisites mentioned above are fulfilled, the present method should be applicable to other narcotic drugs. A study of phenmetrazine signatures is in progress and the results will be reported elsewhere.

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