

Detection of Vapour Metabolites of Glue Sniffer's Urine Using Head Space Gas Chromatography Mass Spectrometry

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Abstract

The abuse of volatile substances has been around for many years. The negative and sometimes fatal conclusion of the abuser led to law being regulated but the problem had spiraled almost out of control due to the ease of availability of the materials abused. The abused substances are most commonly found in products of everyday use such as glue, paint and thinner. In Malaysia, the term 'glue sniffing' is given to the abuser as they inhale glue vapour that gives them the 'high' sensation most drug abusers are seeking for. This study employs gas chromatography-mass spectrometry with head space method for it is the vapour that is inhaled by the abuser, thus during secretion in urine, vapour metabolites are expected. Samples for the study are 4 commercially available glues that are reported as being the most commonly abused as well as the urine samples of probable glue sniffers taken during a raid by the Malaysia Anti Drug Agency, Johor branch. In this study, toluene was shown as the major solvent compound found in glue, and metabolites of toluene, namely p-cresol and N-(methylbenzoyl)-methyl ester-glycine were detected in urine samples of those who are positive for glue sniffing.

Keywords: Glue; Toluene; Gas chromatography-mass spectroscopy detector; Head space; Hippuric acid

Introduction

For many years, the problem of volatile substance abuse has been around. These substances have the potential to cause major physiological and neurological damage that, in many cases, cannot be remedied. Furthermore, the severe physical damage associated with inhalant abuse has been documented extensively. These volatile substances being inhaled by abusers are recorded worldwide which led to regulations and law being implemented but to no avail in controlling the act from getting any worse [1].

In Malaysia, the abuse of organic volatile solvents has been observed since the early 1980s. The problem of solvent abuse is predominant in East Malaysia (i.e., Sabah and Sarawak) and in Johore the southern part of West Malaysia bordering Singapore [2]. The substances abused include paint thinner, nail polish remover, gasoline and the most frequently abused type of inhalant being glue. The types of glue most often abused frequently have an organic solvent which is toluene [3]. This solvent has a boiling point lower than room temperature. The solvent in glue have a long term negative health effect when inhaled. After inhalation, the vapor gives the user the delusional feeling which will slowly lead to a general feeling of hallucination or 'high'. In some respects, solvent in glue is even more abused than drugs. This is because glue is generally easier to get and cheaper than drugs [4].

Toluene is the solvent with the most documentation of abuse, possibly because of its relative low risk of sudden death and the ease of detection in blood. It is found in many products including paint and contact adhesives. The principal metabolite of the toluene is benzoic acid (approximately 80% of dose) which is conjugated with the glycine to form hippuric acid for excretion in urine (half-life of 2-3 hour) [5].

The inhalation of toluene in glue by glue sniffers in Malaysia is a growing problem. The exact number or documentation of the number of glue sniffers is not available as glue or solvent abuse is considered as an alternative to drugs, thus it is not reported to the national registry of abusers in Malaysia. A gleam future awaits the country if the problem

is not addressed correctly and swiftly from now on as it is feared that it will be out of hand when the responsible enforcement agencies could not stop it anymore [6]. Furthermore, there is no law that in Malaysia that is exclusively regulated for these abusers currently [3].

As the solvents in the glue inhaled are volatile substances, head space method may be the best method in 'capturing' what exactly is the glue sniffers are inhaling. In this study, the most commonly abused glue types are identified and the properties of the glue are determined using gas spectrometer mass spectrometry using head space method. Blood and urine samples of glue sniffers are also being studied via the same method. This project has considerable potential and the positive impact of its findings to Malaysia and the society can be high. The results of this project will go a long way towards helping the Royal Police and National Anti-Drug agency to prevent this problem from becoming worse.

Materials and Methods

Instrumentation

GC-MSD head space utilized 10 μ L head space Hamilton syringe from Agilent Technologies, USA with a HP-5 capillary column of dimension 30 m x 0.30 μ m x 0.30 mm brand J&W Scientific, USA. An isothermal condition employed with 65°C for 45 minutes, initial oven temperature at 150°C, injector temperature was set at 150°C, detector temperature at 200°C and helium flow rate of 0.7 mL/min [7].

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Local glue sample selection

After an interview session conducted on more than 50 respondents, four different glue samples were selected as the sample for the research. Based on the result of the interview, these four glues brands were the most reported being abused. They are Dunlop glue, Good Mark CA glue, GP glue and Wessbond glue (shoe glue). All the glues were purchased at hardware shops around Taman Universiti, Skudai, Johor Bahru, Johor.

Urine samples

Urine samples from Sultanah Aminah Hospital, Johor Bahru and three secondary schools in Johor Bahru area were obtained during a raid with the co-operation of the National Anti Drug Agency. All of the urine samples obtained were then screened using G.S. Kit [6] prior to confirmation test using GC-MS with head space method.

Preparation of toluene standard

1 mL of toluene 99.7% was pipetted into a 100 mL volumetric flask and then made up to the mark with dichloromethane 99.7%. Toluene standard was sonicated in ultrasonic water bath.

Sample preparation

The urine samples were added with sodium fluoride as preservative were stored at 0-5°C. 10 mL of urine sample was placed in a head space bottle. The samples were heated in the oven at 100°C for ½ hour. The headspace was withdrawn with a headspace syringe and injected at the GC-MSD.

Results

Local glue sample results

The percentage of abundance of toluene found in all 4 glue samples using Gas Chromatography Mass Spectroscopy (GC-MSD) using head space method are tabulated in Table 1 below.

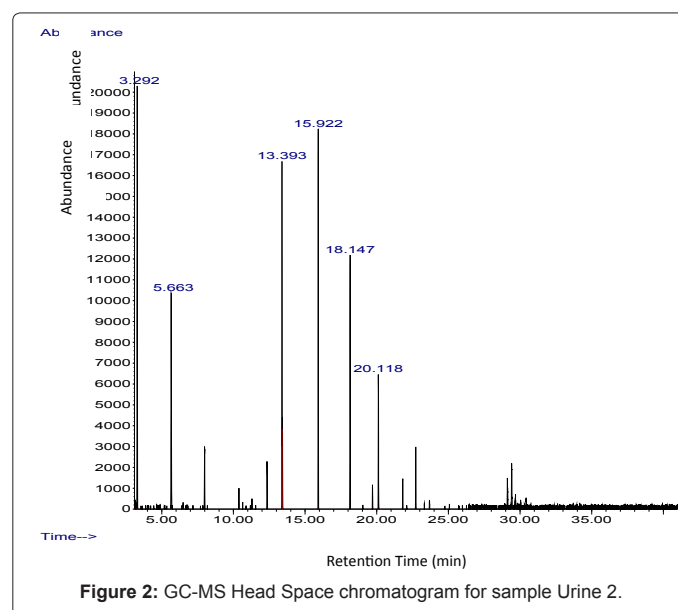
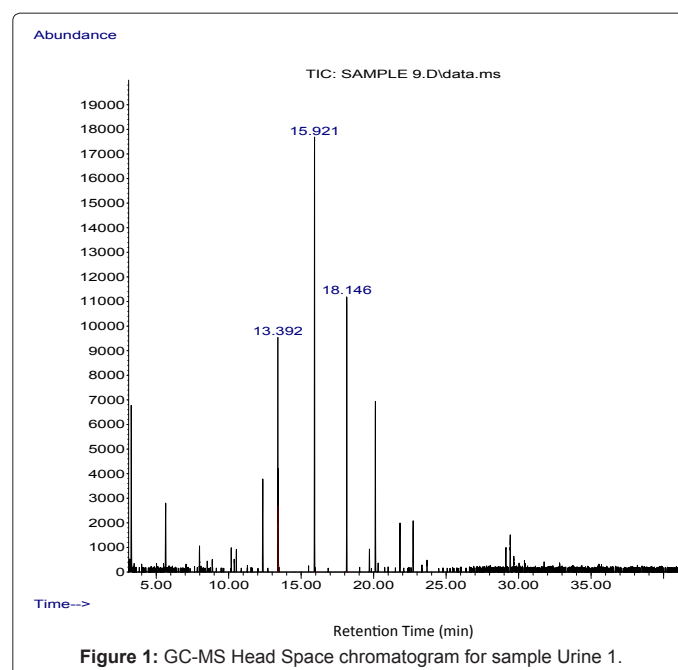
According to the results shown, toluene was the major compound that existed in all 4 glue samples analyzed.

Toluene metabolite results

GC-MSD with headspace method was used for qualitative analysis for determination of toluene metabolites in this research. All the samples were analyzed by this method and the results are showed in Figure 1, 2, 3 and 4. The following figures 5 and 6 are GC-MS Head Space library chromatogram of N-(methylbenzoyl)-methyl ester-glycine and *p*-cresol respectively.

Glue brand	Substance detected	Abundance (%)
Dunlop	Toluene	91.1
GP	Toluene	91.1
Good Mark CA	Toluene	92.1
Wessbond	Toluene	91.1

Table 1: Substance detected and the abundance of the detected substance in glue samples using Gas Chromatography Mass Spectroscopy (GC-MSD) using head space method.



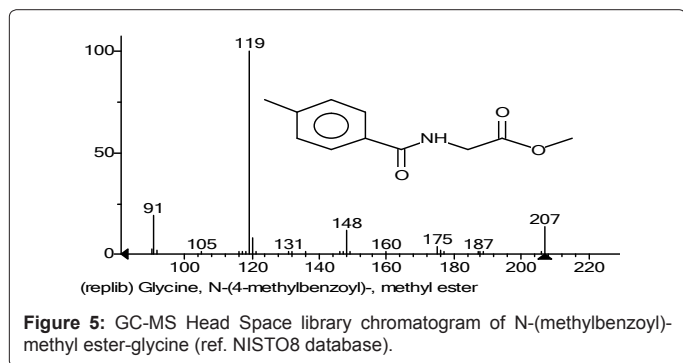
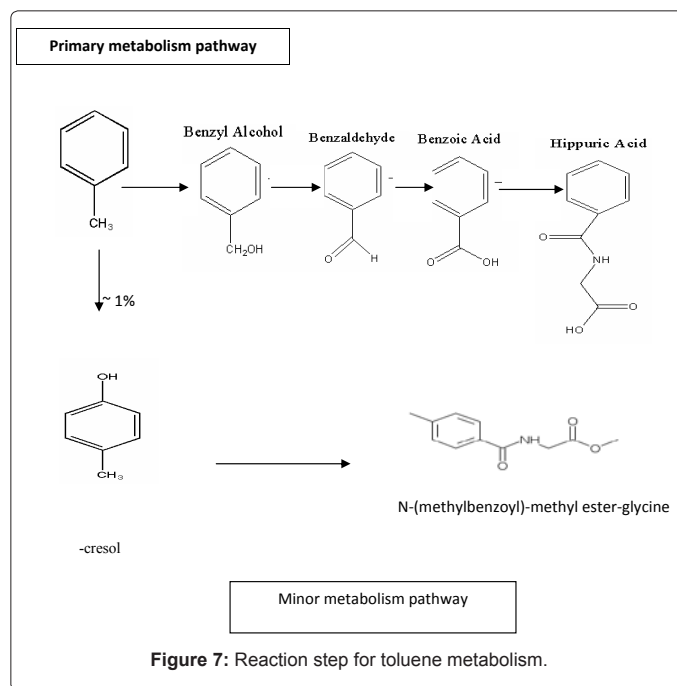
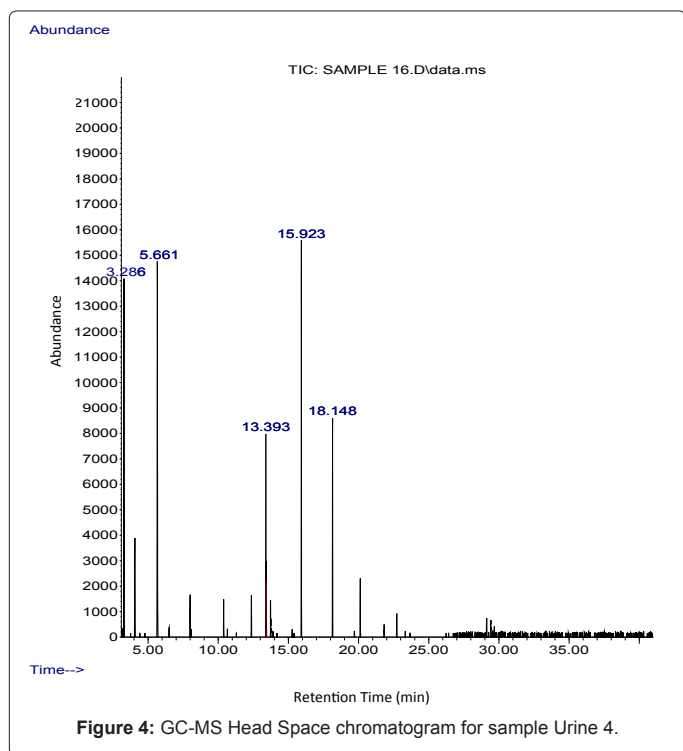
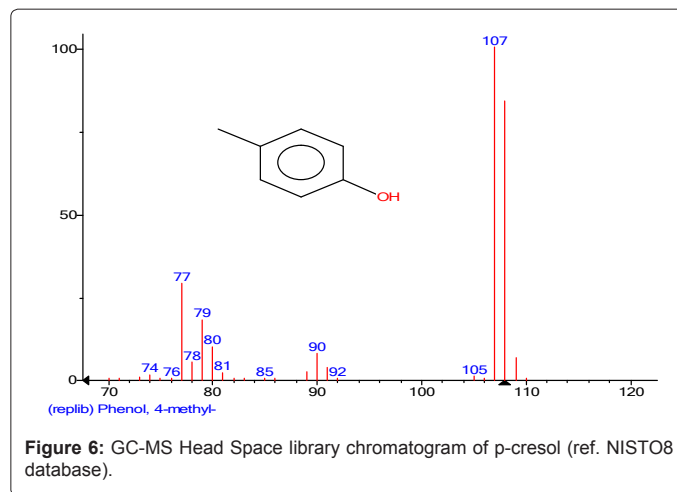
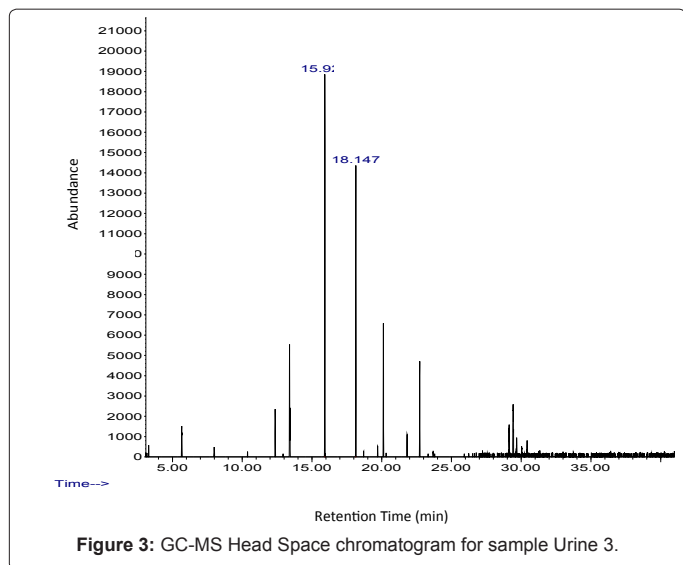
Discussion

Local glue analysis

The head space method easily separated the toluene substance compared to the usual Gas Chromatography Mass Spectroscopy Detector. This was because toluene has lower boiling point thus it easily evaporates making it a volatile compound that was suitable for head space method.

Urine samples analysis

From the results (refer Figure 1-6), positive urine samples were 1, 2, 3 and 4. All of these positive samples contained *p*-cresol compound and urine samples 1 and 2 had N-(methylbenzoyl)-methyl ester-glycine. In



this case, the *N*-(methylbenzoyl)-methyl ester-glycine has a similar structure as a hippuric acid. This proves that urine samples 1 and 2 have a high concentration of hippuric acid. The *p*-cresol compound present in urine samples 1, 2, 3 and 4 is one of toluene metabolites. Approximations of 0.4-1.1 % *p*- and *o*-cresol are produced when an individual is exposed to toluene [8]. Thus, the detection of *p*-cresol in this amount range may indicate that the person was exposed to high concentration of toluene or had sniffed toluene vapour directly. As the results indicated, it was proven that the samples 1, 2, 3 and 4 have been exposed to toluene and indicated that these persons were glue sniffers.

The following reactions were deduced based on the results obtained from the study. **Figure 7** show the most probable reaction step of metabolism of toluene based on the results.

Conclusion

The results show that toluene is the major solvent found in glue samples analyzed. Toluene is used in industry for the synthesis of the

chemical compound and as the solvent for paint, print ink and adhesive. In the glue samples, toluene is indicated as the solvent for adhesive materials that are included in this group. In this case, the research objectives are the determination and analysis of the major component of glues, which is toluene. Because of that the study will focus only on toluene sample and its derivatives that may be present in urine samples after sniffing the glue. Toluene metabolites such as *p*-cresol and N-(methylbenzoyl)-methyl ester-glycine were demonstrated to be present in urine samples of individuals that have been glue sniffing prior to their urine being sampled. GC-MS with head space method has proven to be an easier confirmation test in comparison to GC-MSD as the analytic are volatile compounds.

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