

**FORENSIC ANALYSIS OF C4 EXPLOSIVE RESIDUES ON  
POST BLAST HAIR SAMPLES**

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requirements for the award of the degree of  
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*I dedicated this work to my beloved parents, Hjh. Normah Binti Abd Rahman, my dearest siblings, supportive supervisor and co-supervisor, not forget to my colleagues and coursemates.*

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## ABSTRACT

The occurrence of crimes involving high explosives in Malaysia in recent years has warrant the need for the analysis of high explosives in post blast samples, particularly residues that could be found on hairs of victims. This study reports on the detection of post blast residues of C4 explosives on human head hairs. Natural and dyed human head hairs were selected as hair sample in this research. The identification of human head hair on its medullary index (MI) was conducted by using microscopic examination. All hair samples gave MI values of 0.13  $\mu\text{m}$  to 0.29  $\mu\text{m}$  indicative of human head hairs. Prior to a simulated explosion, a bundle of hair (200 strands) was tightly bound to a metal hook at each point of several pre-determined distances from the blast point. Hair samples containing post blast residues were extracted by ultrasonication using acetonitrile. Two analytes of interest, cyclotrimethylenetrinitramine (RDX) and pentaerythritol tetranitrate (PETN) were successfully separated using gas chromatography with electron capture detector (GC-ECD) on an HP5-MS capillary column. It was found that the amount of explosive residues decreased with increasing distance from the point of blast. At the nearest specified distance of 2.5 m, the amount of PETN residues deposited on hair was much less compared to that of RDX residues.

## ABSTRAK

Terjadinya kes-kes jenayah yang melibatkan bahan letupan berkuasa tinggi di Malaysia telah membuka ruang kajian terhadap sampel pasca letupan, terutamanya residu yang boleh dijumpai pada rambut mangsa. Kajian ini melaporkan pengesanan residu letupan bagi bahan letupan C4 pada rambut manusia. Rambut manusia yang asli dan yang telah diwarnakan telah dipilih sebagai sampel subjek letupan. Kajian ke atas sampel rambut kepala manusia berdasarkan index medulla dilakukan dengan ujian mikroskopik. Kesemua sampel rambut mencatat bacaan MI antara 0.13  $\mu\text{m}$  hingga 0.29  $\mu\text{m}$  yang dikelaskan dalam rambut kepala manusia. Sebelum letupan simulasi, sejumlah rambut (200 helai) telah diikat pada mata kail logam bagi setiap jarak berdasarkan pada kedudukan yang berbeza dari pusat letupan. Bahan letupan C4 yang terdapat pada rambut telah diekstrak secara ultrasonik dengan menggunakan asetonitril. Dua analit kajian, iaitu siklotrimetilenatrinitramina (RDX) dan pentaeritritol tetranitrat (PETN) telah berjaya dipisahkan menggunakan kromatografi gas dengan pengesan tangkapan elektron (GC-ECD) menggunakan turus rerambut HP5-MS. Kajian mendapati bahawa amaun residu bahan letupan berkurangan dengan pertambahan jarak daripada pusat letupan. Bagi jarak dekat tertentu iaitu pada 2.5 m, amaun residu PETN yang terdapat pada rambut adalah amat kurang berbanding residu RDX.

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**LIST OF ABBREVIATION**

2,4 - DNT	2,4- dinitrotoluene
3,4 - DNT	3,4- dinitrotoluene
ACN	Acetonitrile
ANFO	Ammonium Nitrate Fuel Oil
DNA	Deoxyribonucleic Acid
ECD	Electron Capture Detector
EGDN	Ethylene Glycol Dinitrate
FID	Flame Ionization Detector
HMX	Cyclotetramethylenetetranitramine
HPLC	High Performance Liquid Chromatography
GC	Gas Chromatography
LOD	Limit of Detection
MS	Mass Spectra
NG	Nitroglycerin
PETN	Pentaerythritoltetranitrate
RDX	Cyclotrimethylenetrinitramine
SEM	Scanning Electron Microscopy
TATP	Triacetone triperoxide
TEA	Thermal Energy Analyzer
TNT	2,4,6- dinitrotoluene

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Background of study problem**

Criminal cases involving explosives are crimes often used by criminals in order to destruct and vanish the evidence. The murder of a Mongolian citizen in Malaysia that occurred in October 2006 would be the best example. The high profile has led to how the victim has been exploded by C-4 in the jungle. Fragments of skeleton and hairs evidence were part of the investigation. Apart from the studies of deoxyribonucleic acid (DNA) analysis in hair, the type of explosive can be determined by employing a chemical analysis.

Forensic scientists have extensively researched on drug analysis on hair. Drug detection in hair has been a motivating research by scientist during the last 15 years. In 1954, barbiturate was the first organic drug detectable in guinea-pig hair (Gaillard

and Pepin, 1997). The illegal drugs and the presence of heavy metal and other chemical in the body can be detected by performing hair analysis. The exposure of chemical vapor to hairs sample has been conducted by some researchers in the mid 1900's (Oxley *et al.*, 2005). In addition, hair provides information of historical record of chemical exposure of surrounding.

Explosives appear in massive kinetic energy that can produce an explosion. There are several factors that can initiate the explosive to explode such as liberation of heat and development of sudden pressure. The analysis of explosive has been divided into two types namely a pre blast analysis and post blast analysis (Johns *et al.*, 2007).

The residues of after post blasts explosives usually are invisible to human naked eyes, particularly when the residues are deposited in layers of debris material. The explosives can be determined in either of qualitative and quantitative by doing an analysis on the debris material collected close to point of explosion. The analytical techniques for analyzing the origin of explosives depend on the type of explosives, as to whether it is an organic or inorganic material. It is difficult to identify the type of explosives at the crime scene. Therefore, selecting on the right analytical technique without damaging the evidence is a requirement because of limited evidence amount of post blast residues. Thus, the advantages, limitation and the sensitivity range of various techniques for detection of the explosives must be considered first.



## 1.2 Problem Statement

After an explosion, the vicinity around the blast seat is often strewn with post blast fragments containing explosive residues. Human head hairs of victims or spectators are also likely to sorb unreacted or remaining explosive that were used for the explosion. Due to an increase number of human head hairs encountered as post blast samples, it was therefore necessary to undertake a study to develop method for the analysis of explosive residues in human hair.

## 1.3 Objectives of Study

The objectives of this study are:

- i. To investigate the absorption level of explosive in hair based on:
  - a. Distance from bom seat with the hair sample
  - b. The natural and dyed hair
- ii. To study all possible factor that effect explosive adsorption into hair

#### **1.4 Scope of the Study**

The scope of this study involved the use of human head hairs of natural and dyed color will be utilized. Explosion residues in human head sample are detected by employing GC-ECD.

#### **1.4 Significance of the Study**

The results of this study will be made available to forensic chemists in government laboratories such as Department of Chemistry Malaysia. The developed method will hopefully be useful and can be proposed as a standard method for explosive analysis in hair samples. Levels of explosive residues in hairs will also be of assistance to police investigations for the purpose of post blast identification (PBI).

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