An Investigation into the Impact of Firearm Storage Conditions on Changes in Nitrite ion Levels in Gunshot Residue within the Barrel

Napaporn Muenpaeng[1], Thitichaya Thattiwong[2], Aphiwat Teerawutgulrag[1]
[1]Department of Chemistry Faculty of Science, Chiangmai University, Chiang Mai 50200, Thailand
[2]Firearm and Ammunition Identification Subdivision, Police Forensic Center 5, Lampang 52000, Thailand

Abstract

Nitrite ion is an important chemical indicator in the examination of gunshot residue (GSR) within firearm barrel, particularly for estimating the elapsed time after firing. The standard analytical method for detecting nitrite ions in GSR is Griess test, which uses sulfanilic acid and N-(1-Naphthyl)ethylenediamine dihydrochloride (NEDA) to form a pink to red azo dye through Diazotization and Coupling reactions.

This study examined the effect of firearm storage environments on the detectable amount of nitrite ion in GSR. Two semi-automatic pistols, SIG Sauer P226 (9 mm LUGER) and Walther TPH (.22 LR), were used to evaluate nitrite ion variation under three conditions: immediate analysis after firing, sealed storage protected from light and humidity, and open storage exposed to air circulation or carried by an officer during duty for one week, with all experiments performed in triplicate. Colorimetric analysis was performed using the Griess test with sulfanilic acid in acetic acid and NEDA in methanol. The color intensity and brightness of the developed solutions were measured using the Color Identifier application and an online color analysis tool based on CMYK and RGB systems. The Magenta (M) value generally decreased while brightness increased over time compared with immediate analysis, with the largest changes occurring under open storage due to air exposure, humidity, and mechanical disturbance from carrying. These variations reflect differences in the detectable amount of nitrite ion in GSR under different storage conditions, highlighting the relationship between environmental factors and nitrite ion stability.

Introduction

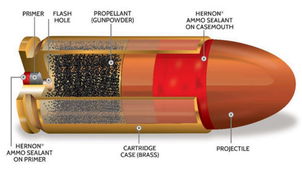


Fig.1 Components of a firearm cartridge

Crime in Thailand has shown a continuous upward trend, and previous studies have indicated that firearms are the most commonly used weapons in criminal cases, resulting in a large amount of important physical evidence at crime scenes. At present, scientific evidence is widely accepted in the justice system, and one of the most important types of such evidence is gunshot residue (GSR). Gunshot residue consists of nitrates and nitrites produced from the combustion of gunpowder, as well as metallic particles originating from bullets and cartridge cases, which can be detected on firearms and related objects. However, the amount of nitrite present may vary depending on environmental conditions and firearm storage methods prior to forensic examination. Therefore, investigating the effects of firearm storage conditions before nitrite analysis is essential to improve the accuracy and reliability of forensic results. The experimental data obtained in this study will be compiled into a database to support forensic scientists in evaluating nitrite detection results from firearms stored under different environmental conditions and to enhance the scientific reliability of evidence used in judicial proceedings.

Objective

To investigate the effect of different post-firing firearm storage environments on the detectable nitrite ion levels in gunshot residue inside the barrel, and to evaluate and compare the detection performance under these conditions.

Methodology

Griess Test

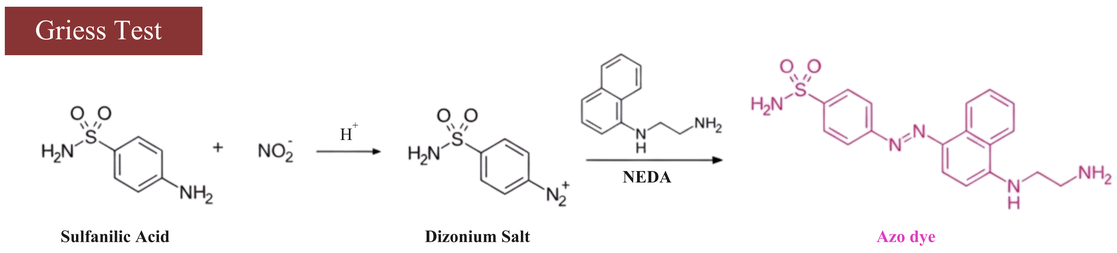
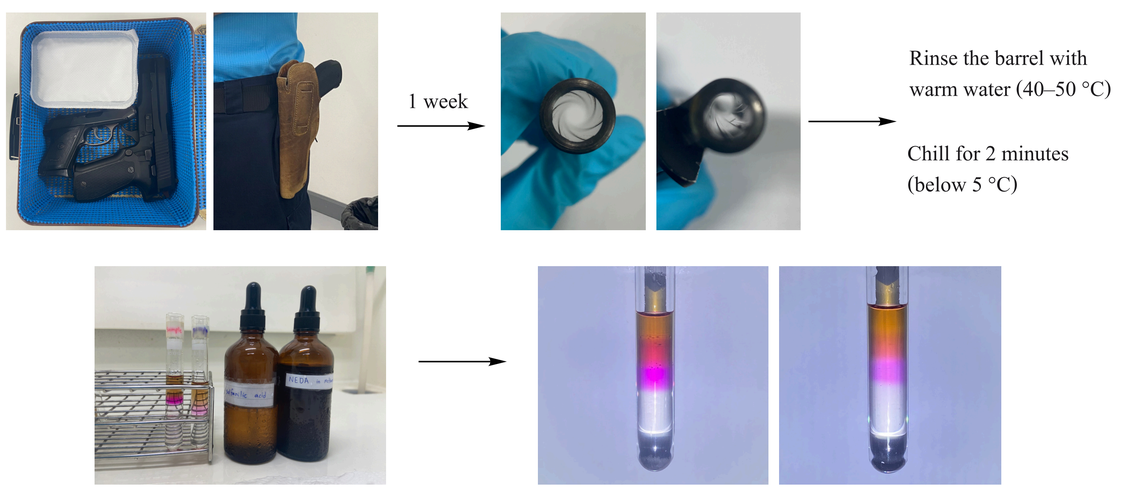
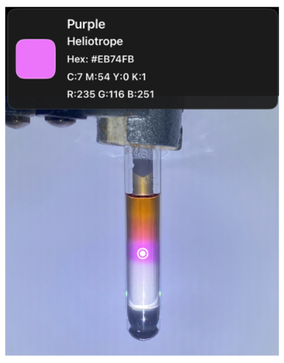


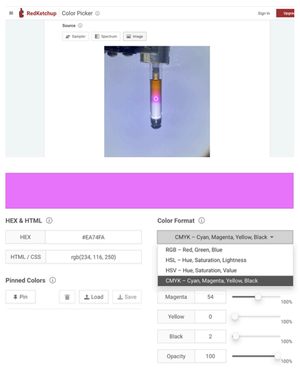
Fig.2 Reaction mechanism of the Griess Test



CMYK and RGB Analysis

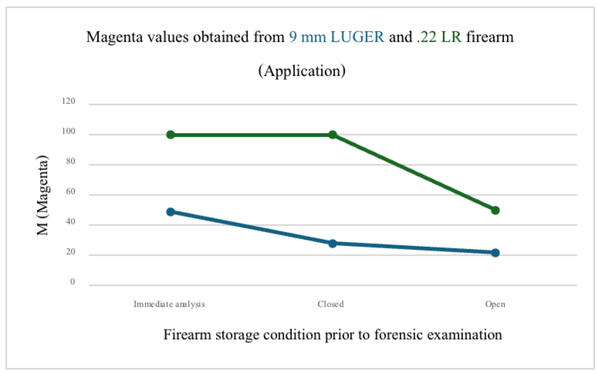


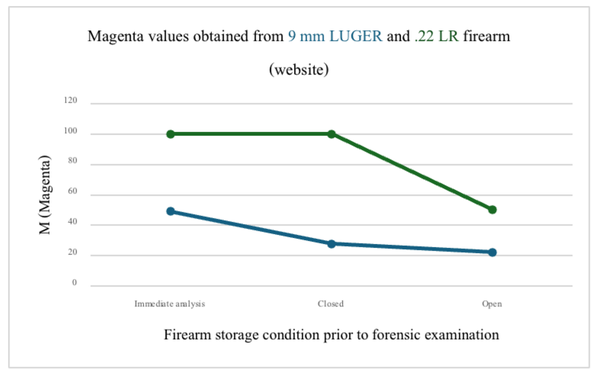
Application: Color Identifier

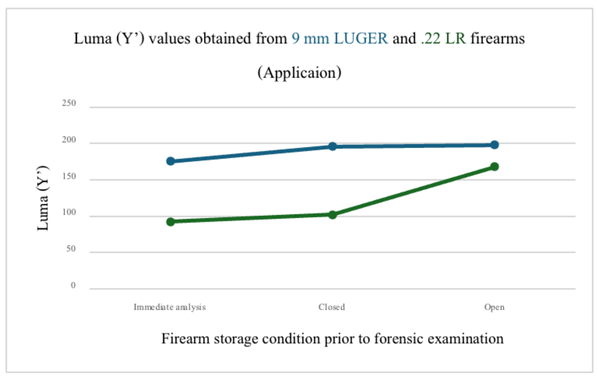


Website: RedKetchup

Results and Discussion







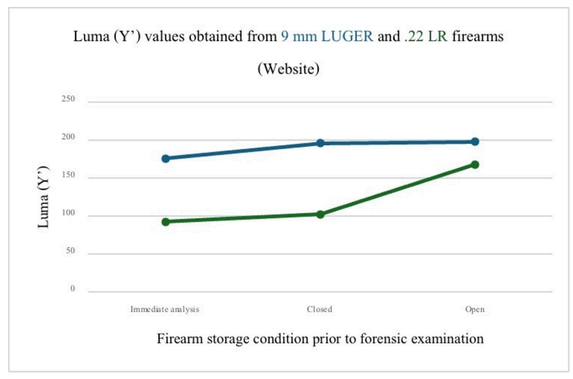


Fig.3 Graph of magenta and Luma values obtained from 9 mm LUGER and .22 LR firearms under three firearms storage conditions

The storage environment of firearms has a direct influence on the persistence of nitrite ions in gunshot residue. Storage under sealed conditions can retard the degradation of nitrite more effectively than storage in an open-air environment. The analysis of the Magenta value and brightness derived from the RGB color system showed trends consistent with the qualitative observation of the Azo-dye coloration, indicating that color intensity decreased with time and that nitrite levels declined more rapidly under open-air conditions. These findings reflect the effects of air, humidity, oxygen, temperature, and mechanical disturbance during carrying, all of which promote oxidation reactions and accelerate the degradation of nitrite ions.

Conclusions

- Sealed storage of firearms prior to forensic examination more effectively preserves nitrite ions in gunshot residue than storage under open-air conditions.
- The Magenta value and brightness obtained from photographic images can be used as supporting indicators for assessing changes in nitrite levels.
- The findings highlight the importance of proper handling and storage of firearm evidence in order to reduce analytical uncertainty, and they can serve as preliminary information for estimating the time since the firearm was last used.

References

1. Jarujinda. Pol. Maj. Gen. (1999). Firearm and Ammunition Examination. General knowledge document on firearms and ammunition for trainees, Forensic Science Division, Office of Police Forensic Science.
2. Gunshot Residue Detection Technologies : A Review (2021), Egyptian Journal of Forensic Sciences. Techniques: Griess test (Walker's test), Modified Griess test.

Acknowledgement

I would like to express my heartfelt gratitude to Asst. Prof. Dr. Aphiwat Teerawutgulrag for providing invaluable guidance, constructive advice, and continuous support throughout this research project. I would also like to sincerely thank Pol. Maj. Tihtichaya Thattiwong and the mentors in the department for their valuable knowledge, kind assistance, and encouragement during the entire period of this study. Finally, I would like to express my sincere appreciation to the Forensic Science Division, Royal Thai Police, Thailand, for providing the opportunity to participate in the cooperative education program and for their support and facilitation in conducting this research.