IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 10, October 2022

Study of Firecracker Content of Various Manufacturers

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ABSTRACT: ***This study is needed because illicit manufacture, accidental fires, arson, and other crimes are on the rise. It is important to examine the fireworks to determine whether or not were produced according to standard process that follows focuses on the many instrumentations and colorimetric measurements that are used to identify the precise structure and percentage ratio of unique fire crackers. Electron Microscopy, and Potentiometer are the most commonly used instruments. They're used to figure out items like anions, cations, other metals, organic substances, resins, and so on. Different brands of firecrackers from various manufacturing firms were purchased and evaluated in the tests detailed below. Despite the high frequency of explosive injuries in India, little studies on the quality evaluation of fire crackers have been performed in the country. The bulk of the research has been done on incidents that have occurred in the United States. It is important that greater research of explosions, explosives, and explosive debris be done in order to help in the investigation of these events. Researchers will determine whether any heavy explosive substance is used to increase the effectiveness of the fire crackers, which may be as powerful as a bomb.***

KEYWORDS: ***Analysis, Blast Particles, Chemical, Composition, Consumer Fireworks, Explosives, Fire Crackers, Methods, Powder, Pyrotechnic, Research.***

1. INTRODUCTION

Forensic chemistry is a field of research concerned with the use of chemical evidence in judicial procedures. It is primarily concerned with the study of different compounds. Petroleum oil analysis, fire residue analysis, explosive residue analysis, cement analysis, and so forth. The most common kind of evidence found in blasting cases is explosive remains (Figure 1).

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Fig. 1: There Is Nothing Green About Firecrackers. Green Firecrackers Will Generate 70 Percent Of The Emissions That A Normal Specimen Produces.

Every material or system that produces a significant amount of rapidly spreading gas in a short period of time is termed explosive. It is classified into three categories: electrical, chemical, and nuclear. Mechanical explosives, as their name indicates, go through a physical action that causes them to explode (e.g. explosion of a container which fills with compressed air). It is less commonly used in mining. The second kind is a nuclear explosion, which is characterized by a protracted nuclear reaction that is both quick and rapid, releasing significant quantities of radiation (e.g. in petroleum extraction purposes). Much of the time, people come across chemical explosives that are reliant on a chemical reaction that generates the explosion [1].

Chemical explosives may be divided into two categories: (1) detonating explosives and (2) deflagrating explosives. Detonating explosives are characterized by quick decomposition and high pressure production, whereas deflagrating explosives are characterized by rapid burning and low pressure output. Any typically deflagrating explosives may be made to detonate under such circumstances, such as the use of huge amounts and a high degree of confinement. Main and secondary detonating explosives are the most common subcategories. Primary explosives detonate when they are ignited by a source of fire, such as a flame, a spark, an impact, or another mechanism. A detonator is used for secondary explosives, and it may also serve as a booster in certain situations. Depending on the circumstances of use, a few explosives may be both primary and secondary [2].

They detonate at speeds ranging from 3000 to 9000 M/S, making them detonating or high explosives. Primary and secondary explosives are the two types of explosives that are typically classified based on their sensitivity [3]. The phenomenon of deflagration causes deflagrating or low explosives to ignite at a subsonic speed. In contrast to other high explosives, it burns very quickly. The deflagration rates range from a few millimeters per second to 400 meters per second. They are often used as propellants. For example, smokeless powder and gun powder. Pyrotechnics is one of the most common types of deflagrating explosives. Since it is focused on the deflagration phenomenon, it works. There are mixtures of different chemicals designed to generate heat, sound, light, steam, smoke, or a combination of these effects through self-sustaining exothermic reactions. Military pyrotechnics and firework compositions are among them. This are manufactured under quality supervision or with a legal authorization [4].

Pyrotechnics include fire crackers, which are one of the most popular types of pyrotechnics. It is a lightweight explosive device that is primarily used to generate sound and light effects for various celebrations. The explosive components are combined together in exact ratios and packaged in paper or cardboard canisters. It consists of a mixture of oxidizers such as sodium nitrate, potassium chlorate, and other inorganic explosive products (charcoal, aluminum powder, and so on). They mix various color-producing chemicals, such as metal salts, into these products. Binding compounds like dextrin, as well as stabilizers like linseed oil and boric acid, are used [5]. Carbon, oxidizer, colorants, binder, and stabilizer are the five fundamental components of fire crackers. The self-burning fuel that produces light and heat. Oxidizers are devices that provide oxygen to aid in the burning of fuel. Colorants are usually strontium, sodium, or other chloride salts. Binder is the substance that binds the pellet together [6].

2. LITERATURE REVIEW

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T. Baran highlighted to the fact that there have been developed sophisticated equipment and techniques for detecting both military and non-military (mining, pyrotechnic) explosives. The physical and compound trustworthiness of follows, as well as the effects of external improvements and various foundation materials on follows, have all been studied. For hazardous and pyrotechnic compounds, shading testing and naming procedures have been developed. These techniques and procedures may be used to identify unstable materials (military, mining and pyrotechnic). On account of pyrotechnic unstable material reliant on accumulation on the surface, it is possible to choose: (a) a strategy for combining sensitive substances; and (b) an oxidizing specialist and flammable substance [7].

B. Glattstein et al. stated in the paper that a technique for detecting and identifying match head remains in IED post-explosion debris has been discovered. The technique includes visual microscopic examination, Scanning Electron Microscopy/Energy-Dispersive Spectroscopy (SEM/EDS), and spot tests for elemental Sulphur and chlorate ion. The method was employed in 13 exploded pipe bomb events. In twelve of them, match head pieces were recovered and identified [8].

3. DISCUSSION

Forensic Significance

There are many types of fire crackers that is studied in the book is briefly addressed below are provided below:

- Rocket: Outside, one side-loaded rocket tubes are carried in and filled with gun powder wet with water using a drift hammer. The tube in question is packed with fuse that has been chocked. The straw sticks are then connected. Color tablets and the sound shell are positioned at the upper portion of the channel. After that, it was numbered.
- Flower pots: This is made using paper cone tubes. There is a 5 kg: 1.5 kg: 4 kg: 3 kg combination of barium nitrate, saltpeter, aluminum chips, and aluminum powder.
- Sparkles: In wooden boxes, the sparkles were wrapped with a copper-coated thread. The chemical composition is 8 kg: 1.2 kg: 1.3 kg: 3.6 kg: 1.1 kg (barium nitrate, aluminum powder, dextrin, iron fillings, gum, and water). To avoid unexpected reactions, 1 percent boric acid is added. To avoid rusting and reactions with other chemicals in the wet stage, the iron dust is covered with linseed oil or tar. Wet mixing is done using a wooden rod and a hand. The wet chemicals are mixed and then put onto the dipping dish. The wire is put into the frame and gently dipped. Drawn and put in an inclined wooden rack, it is permitted to fly 3 to 4 meters, allowing the surplus chemicals adhering to the wire to fall and the frames to be laid on a table to remove the excess chemical at the top. After that, the frame is dried in a drying room. To achieve the desired thickness, repeat the process 2 to 3 times [9].
- Chinese crackers: The manufacturer receives various types of paper tubes in hollow metal rings, each holding 500 to 600 tubes with one side sealed with dirt. The tube rings in question are transported to the white powder filled chamber. The white powder mixture is poured into the containers, and the rings that hold the tubes are shaken until they are all sealed. The excess powder in tubes and the quantity of powder in each tube are so easily drained by dexterous movement of the worker's hands and wrists. Clay is used to plug and tube that has been partially filled with powder and has enough empty space at the top for the fuse. The above-mentioned rings are then transported to a processing facility. Again, non-ferrous sticks or nails

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are used to punch the holes that lead to the tube. After it dried, the crackers were braided together using yarn. After that, it was numbered [10].

Pyrotechnic reagents and formulations may be evaluated using a variety of analytical methods. They've given us a lot of knowledge about the characteristics, compatibility, resilience, and behavior of highly energetic materials. Thermal activity, boiling plus melting points, decay temperatures of compound elements, or reaction besides combustion temperatures for pyrotechnic configurations can all be determined using heat flow calorimetry (HFC), thermal gravimetric analysis (TGA), differential thermal analysis (DTA), as well as differential scanning calorimetry (DSC). Physical characteristics including particle size and form, which are essential for pyrotechnic combinations, have been studied using different methods like X-ray scattering alongside electron microscopy. All of these experiments are helpful in developing reliable and efficient formulations, as well as improving system management and pyrotechnic mixture storage. There is a need for effective, quick, and accurate analytical methods that may be used on a daily basis in forensics. In forensic labs, there are a variety of analytical methods that may be used to evaluate explosive compounds. Until date, several forensic labs have investigated consumer fireworks using a variety of methods based on the Technical Working Group for Fire plus Explosions (TWGFEX) Examinations recommendations for forensic identification of integral explosives besides post-blast explosive remains. Several inquiry papers have been produced that provide essential information about consumer fireworks analysis. As a result, scientists explain and critically assess the major methodological methods used to date for market fireworks research in this article.

Colorimetric research may be performed to obtain qualitative information about fireworks or their remains. Although they have poor precision plus reliability, installation is simple and comfortable, providing read simply. Colorimetric measurements are also used in some quantitative techniques. Chapman, for example, devised and tested two quantitative techniques in 1997, one to measure the quantity of Sulphur alongside other to estimate chlorate amount in fundamental consumer firecrackers. Pyrotechnic combinations containing chlorate alongside Sulphur are prohibited in the United Kingdom as well as other countries, and their supervision is important. As a consequence of its use in detecting instruments that do not match the criteria, quantitative techniques were recommended to be utilized regularly to regulate firework composition resulting in a significant number of measurement errors. The accuracy of the measurement depends uniformity of the mixture. Furthermore, each analysis must be analyzed using a different instrument.

Post-blast fragments from consumer firecrackers show a spheroid shape comparable to bullet remains. As a result, just like proofs, SEM plus energy dispersive X-Ray spectrometry (SEM-EDS) technique may be utilized to analyze pyrotechnic components. Several authors have attempted to describe the composition besides fundamental sketch of component part from pyrotechnic combinations using industrial firecrackers since then. Looked examined post-blast pieces from ordinary market firecrackers, three different colored firecracker, as well as four flash powders compositions in 2001. Based upon the structure of the new powder then whether it is ignited restricted or uncontrolled, the author addressed morphological and elemental variations in particles. The post-blast particles in the seven compounds were irregular except spheroid. Furthermore, the fundamental configuration of the post-blast bits was found to be comparable to that of the original material in the majority of the experiments. However, some components of the original combination are not present in the spheroid post-blast bits, according to certain studies. Phillips hypothesized that the variations in mineral

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composition may be the result of various pyrotechnic product reactions and vaporization temperatures.

They gave further details about how the particle's spheroid shape and size may change. They also investigated the spontaneous quantitative changes in compound components detected in post-blast bits compared to pre-blast bits from commercial fireworks flash plus black powders. Some chemical components found in the unreacted structure of flash powder were absent in different post-blast pieces, or peak sizes varied, as in Sulphur, chlorine, or potassium. The lack of reaction gases was ascribed for the discrepancies. Any chemical molecules interacted to produce new ones, such example Sulphur to sulfur-dioxide gas. The identification of components in post-blast fragments may also be influenced by the compound's melting and boiling temperatures, according to the authors. They also addressed the problem of context pollution in detecting post-blast pyrotechnic remains and offered recommendations on how to improve the analysis' accuracy. SEM-EDS is an useful technique for determining the fundamental structure of pyrotechnics rapidly and with a high degree of precision in the analysis of pre-blast as well as post-blast particles.

Utilizing atomic fluorescence spectroscopy and inductively-coupled plasma (ICP) spectroscopy, researchers assessed six integral consumer firecrackers commercially marketed. The aim of the research was to examine how consumer fireworks contribute to cumulative emissions of environmentally harmful components. Aluminum, barium, magnesium, and potassium, among other metallic elements, were used in significant quantities. There were also trace quantities of zinc, iron, strontium, plus copper. Trace amounts of zinc plus calcium are found. They asked of suppliers of a variety of products that were close to category 1, 2, and 3 firecrackers. Utilizing two dissimilar forms of end plugs plus three kinds of cardboard tubes, powders comprised of barium nitrate-aluminum and potassium perchlorate-aluminum along with various disposable explosive substances were created. The oxidizing metal ions in the combinations is assessed using atomic emission spectroscopy (AES). They discovered a strong relationship with the grade of metallic compounds in pyrotechnic mixes outside the manufacturer's specified percent. According to numerous current study, vibrational spectroscopic methods may be used to assess volatile mixtures. According to Castro, Raman as well as the Fourier-transform infrared (FTIR) techniques are useful for identifying the chemical structure of consumer firecrackers. They used FTIR and Raman spectroscopy to examine various allegedly consumer as well as putatively spectacular firecrackers, utilizing SEM-EDS as a backup equipment. Shellac, titanium bits, nitrocellulose, plus various nitrates, among other substances, are calculated in solid combinations. Raman analysis of particles from various samples revealed molecular spectrum related to barium nitrates, potassium, plus strontium that were among the most commonly utilized oxidizers. Raman was used to identify nitrate compounds since the wavenumber of every nitrate salt was reliant upon the positive-ion. Significant pyrotechnic components, on the other hand, were not calculated by a single method.

4. CONCLUSION

The different techniques, such as instrumental analysis and colorimetric methods, were examined based on the results. Colorimetric tests are helpful for narrowing down samples, but they do not give accurate quantification of the components present. As a consequence, additional study in this area is required to improve the effectiveness of such studies. Instrumental analysis is usually used for thorough analysis, however it is not something that can be done on a regular basis. It is more costly, since it requires greater expertise and skill. The SEM-EDS method is helpful for identifying the elemental composition of preserved

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artifacts and post-blast particles. Atomic spectroscopy is a good instrumentation technique for determining the presence and amounts of metals, among other things.

These techniques help us in establishing the exact structure and ratio of the fireworks mixture. The significance of the analytical procedure, according to forensic experts, is essential. The molecular compositions of conserved consumer fireworks have been identified using FTIR and Raman methods. Since only perchlorate can be measured using the potentiometric techniques that have been developed so far, they are inefficient for laboratory research of consumer fireworks. The methods mentioned above are more exact and descriptive quantitative and qualitative procedures, and they both assist in the standardization of pyrotechnics. Each methodology has unique components, and the final result is a mix of each technique's outcomes, which improves the analyzing process. Researchers will mainly focus on a few studies that have previously been conducted on the basis of a relevant subject involving fire cracker study.

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