Review Article
ISSN:2249-1236
CODEN: IJRRBI
Jupelli Nandini *et al.*, *Int*. J. Res. Rev. Pharm. Appl. Sci.,*(204) 14 (1) 079-085
International Journal of Research and Reviews in Pharmacy and Applied sciences

"STATISTICAL ANALYSIS OF FORENSIC SEROLOGICAL SAMPLES"

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Abstract:

Historically, serology played a key role in forensic science through blood group typing, which was widely used to differentiate individuals and link them to forensic evidence before the advent of DNA profiling. However, since the 1990s, DNA profiling has largely replaced serology, limiting its use to presumptive and confirmatory tests. Despite this, serological analysis remains valuable in cases where DNA evidence is unavailable, such as bloodstains with a low white blood cell count caused by conditions like AIDS.The field of serology is experiencing a revival with the emergence of forensic proteomics, which utilizes soluble proteins for analysis. Proteins, expressed uniquely in different cell types and forms, including enzymes and antibodies, enable serology to differentiate between human tissues (body fluids), individuals, and even species (Geyer et al., 2021}Forensic serology and blood analysis remain vital components of forensic science, offering critical tools for identifying bodily fluids and aiding in legal investigations.

Keywords: Forensic serology, human proteins, DNA profiling, forensic proteomics.

Introduction:

Forensic serology involves the operation of immunological and biochemical ways to identify body fluids or towel samples encountered during crime examinations and to genetically characterize these samples to determine their likely mortal origin(Ballantyne, 2000). Unlike DNA- grounded analysis, this characterization focuses on polymorphic antigens and proteins present in blood cells. Forensic serology primarily involves the identification and examination of fleshly fluids similar to blood, semen, sweat, urine, slaver, and fecal matter for felonious or medicolegal examinations. Blood is the most generally encountered and significant form of substantiation in forensic examinations. It plays a pivotal part in cases of homicide, assault, and terrorist attacks, including bombings. Blood substantiation is vital in the felonious justice system, as it can link a suspect to a crime or count individualities from dubitation, also, bloodstain patterns can give perceptivity into crime scene reconstruction, revealing the relative positions and movements of individualities involved.

At a crime scene, it's essential to determine the type, origin, and other characteristics of blood or bloodstains. The original step involves attesting whether the fluid is blood and if it originates from a mortal. Once verified, farther analyses are performed to identify its characteristics, including blood typing, and examination of proteins, enzymes, and antigens. Blood from white blood cells may also suffer HLA typing. Careful collection of blood substantiation is critical to insure accurate results. Samples must be collected alongside conterminous, unstained areas to confirm that the analysis pertains to mortal fleshly fluids rather than environmental pollutants. ABH antigens, for illustration, are also present in other mammals, bacteria, wood, soil, and dust, and environmental organisms may enzymatically modify blood group antigens. For case, Clostridium spp., Bacillus spp., Aspergillus niger, and indeed coffee sap can alter or exclude blood group substances. Testing for A or B antigens may be judicious when H antigen results are negative, and it's possible to test for anti-Aand anti-B in both stains and fresh body fluids. still, mindfulness of false cons and negatives is pivotal during these analyses. In recent times, DNA technology has largely replaced the use of specific enzyme and protein tests in forensic blood analysis. DNA profiling is now extensively accepted in courts of law encyclopedically and has become a foundation of ultramodern forensic wisdom. nevertheless, blood substantiation, either alone or in confluence with other trace substantiation, remains a critical element in working felonious cases.

Forensic Serology :

Forensic serology focuses on the identification and analysis of mortal fleshly fluids similar as blood, slaver, semen, and urine set up at crime scenes. crucial aspects include

1. Identification and Analysis in Forensic Serology
2. Identification: Determining whether a sample or stain is a bodily fluid.
3. Classification: Identifying the specific type of bodily fluid (e.g., blood, saliva, or semen).
4. Typing: Establishing the genetic profile of the sample, such as blood type or DNA profile.
5. Techniques in Forensic Serology

6. Presumptive Tests: Rapid tests that suggest the presence of a bodily fluid, such as the Kastle-Meyer test for detecting blood.
7. Confirmatory Tests: Specific tests that confirm the identity of a bodily fluid, like the RSID test for semen.
8. DNA Analysis: Extracting DNA from bodily fluids and analyzing it to link the sample to an individual.

Blood Analysis in Forensics:

The forensic examination of blood involves studying bloodstains and patterns to gather crucial information about the crime.Bloodstain Pattern Analysis (BPA): Examining bloodstains to understand the sequence of events at a crime scene. Key factors include:

1. Directionality: Determining the direction blood droplets traveled.
2. Angle of Impact: Identifying the angle at which blood hits a surface.
3. Velocity: Assessing the speed of the blood, categorized as low, medium, or high.
4. **Serological Analysis: Using serological methods to identify and type blood samples:**
5. ABO Typing: Determining blood groups (A, B, AB, or O).
6. Rh Factor Typing: Identifying the presence or absence of the Rh antigen.
7. DNA Profiling: Extracting DNA from blood to identify individuals. This process involves:
8. Short Tandem Repeat (STR) Analysis: Examining specific DNA regions unique to individuals.
9. Y-STR and mtDNA Analysis: Specialized methods are used for certain sample types or when traditional STR analysis is not feasible.

Applications in Forensics:

Crime Scene Investigation: Analyzing bodily fluids to identify victims, and perpetrators, and reconstruct the sequence of events.Paternity Testing: Using DNA from blood or other fluids to determine biological relationships.MissingPerson Identification: Matching DNA from blood or bodily fluids to missing person databases.

Challenges and Considerations:

Degradation: Bodily fluids can degrade over time, potentially compromising the accuracy of the analysis.Contamination: Proper collection and handling are critical to avoid contamination and ensure reliable results

Observations:

In crime scene investigations, forensic serology involves the analysis of bodily fluids such as blood, saliva, and semen to identify and characterize them in connection with the crime. Forensic serologists may also study bloodstain patterns and perform DNA analysis to gather further evidence.Presumptive Tests: These tests suggest the presence of a bodily fluid but are not definitive. For example, a rapid pink color change in a test might indicate blood, but other substances can produce false positives.

Luminol: This chemical is sprayed over a wide area to detect even trace amounts of blood. When it reacts with hemoglobin, it produces a blue glow, revealing bloodstains invisible to the naked eye.

Blood Typing: Blood samples can be tested to determine the blood type, which helps in excluding suspects before conducting DNA testing.

Precipitin Testing: This test confirms whether a blood sample is human, an essential step before proceeding to DNA analysis.

Takayama Confirmatory Test: This test uses a reagent applied to a blood sample, which is then examined under a microscope. The formation of specific crystals confirms the presence of blood.

Field Collection of Blood Samples: If blood cannot be transported to a lab immediately, it can be absorbed onto a small piece of cotton sheeting. The sample should be packaged in paper or plastic. If plastic is used, the sample must be transported within two hours to prevent degradation. Once in a safe location, the sample can be air-dried and repackaged in a paper envelope for further analysis.

Data analysis:

MONTHS 2023	No.of cases	Blood samples received	A+	A-	B+	B-	AB+	AB-	O+	O-
January	4	7	2	0	1	0	1	0	3	0
February	3	8	2	0	0	0	1	0	5	0
March	6	12	4	0	0	0	0	4	4	0
April	8	13	3	0	2	0	3	0	4	1
May	2	4	0	0	0	0	0	4	0	0
June	0	0	0	0	0	0	0	0	0	0
July	2	6	0	0	0	0	3	0	3	0
August	1	3	2	0	0	0	0	0	0	1
September	4	10	0	0	0	5	0	5	0	0
October	5	14	0	0	2	0	6	0	6	0
November	7	12	2	4	0	2	0	4	0	0
December	3	7	0	3	0	3	0	0	1	0
Total	45	96	15	7	5	10	14	17	26	2

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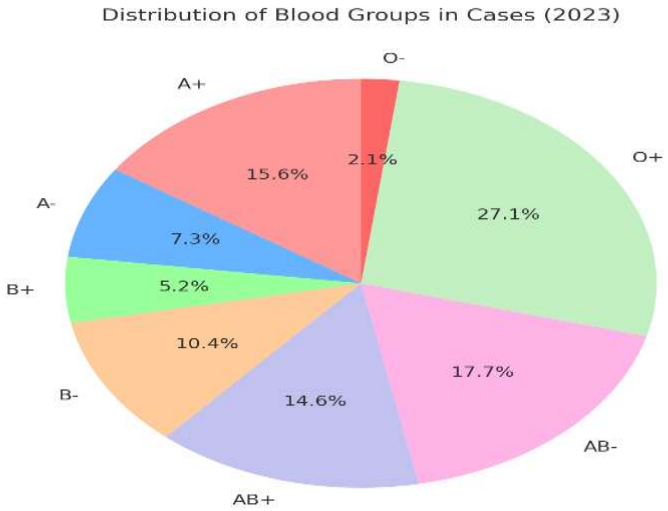

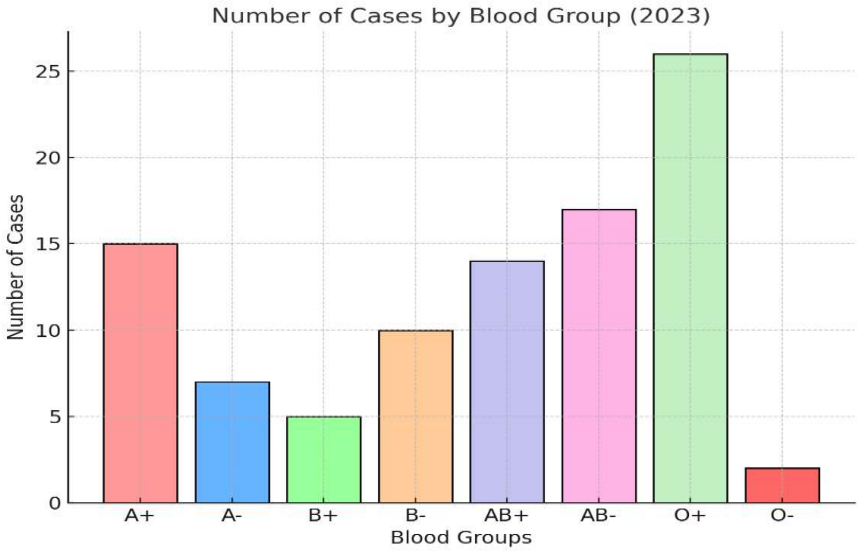

Discussion:

Forensic serology involves the application of immunological and biochemical methods to identify bodily fluids or tissue samples encountered in crime investigations and, if needed, further genetically characterize these samples to determine their likely donors. Serology plays a vital role in addressing source-level questions related to presumed blood traces. It enables the differentiation of blood from various species, individuals, and tissues.The specificity of

antibodies and proteoforms allows a single assay to serve multiple purposes. For instance, an immunochromatographic lateral flow device (LFD) for human blood can confirm the presence of blood (as opposed to other bodily fluids) and determine its human origin (as opposed to other species). Advanced techniques such as protein profiling of iso-enzymes and proteomic analysis of glycoprotein variants (GVPs) can distinguish between individuals and different body fluids. Additionally, proteins expressed differently across life stages can help infer the age of the source. Even postmortem, forensic serology can provide valuable information, such as estimating the postmortem interval (PMI).

In practice, forensic serologists often analyze bloodstains found at crime scenes. Samples are collected, and a series of tests are conducted to extract DNA and other relevant details. Two commonly performed tests are:

Catalytic Test: The Kastle-Meyer test or Hemastix, which analyzes the peroxidase-like activity of hemoglobin.

Takayama Crystal Assay: This test detects the reaction between the iron atom in hemoglobin and pyridine, forming ferroprotoporphyrin crystals.

These methods, along with other advanced techniques, provide critical insights that aid in solving crimes.

Conclusion:

This discussion highlights the importance of forensic serology in crime scene investigation. By focusing on bodily fluids and tissue samples, forensic serology offers a range of techniques to identify and analyze evidence, such as blood, saliva, and semen detection, as well as presumptive and confirmatory testing. These methods play a pivotal role in linking evidence to individuals, reconstructing crime scenes, and identifying suspects.Forensic serology, as a specialized branch of forensic science, serves as a vital tool for crime investigation teams. It equips forensic serologists with the ability to play diverse roles, from evidence collection to detailed analysis, ensuring the accuracy and reliability of investigations. Moreover, the application of forensic serology not only strengthens law enforcement but also contributes to improving societal conditions by upholding justice and maintaining order.

The techniques discussed, such as blood detection, DNA profiling, and confirmatory tests, demonstrate how forensic serology aids in identifying suspects and solving crimes. By leveraging these methods effectively, forensic science continues to make significant contributions to the criminal justice system.

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