



## Review Article

## Saliva as a diagnostic tool in criminal investigation: A scoping review

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## Abstract

Saliva is increasingly recognized as a valuable diagnostic tool in criminal investigations due to its potential for forensic analysis. As a bodily fluid, saliva contains DNA, enzymes, proteins, and other substances that can be used to identify individuals and gather crucial evidence in criminal cases. One of the primary applications of saliva in forensic science is its role in DNA analysis. Saliva contains cells from the inner cheek and mouth lining, which carry unique DNA signatures. These cells can be collected from items like cigarette butts, bottles, or discarded tissues at crime scenes. DNA profiling of saliva can help link a suspect to a crime scene, provide evidence of contact, or exclude individuals from suspicion.

In addition to DNA analysis, saliva also contains biomarkers and substances that may be relevant in specific investigations. For example, the presence of certain drugs, alcohol, or toxins in saliva can provide evidence of intoxication or drug use, which may be pertinent in cases such as impaired driving or poisoning. Furthermore, certain enzymes or proteins found in saliva could help identify injuries or medical conditions that may be relevant in criminal investigations.

Saliva can also serve as trace evidence in cases of sexual assault or violent crimes. When collected properly, saliva left at a crime scene can provide critical evidence of contact between a victim and a perpetrator, aiding in the identification of the suspect.

Overall, saliva is a non-invasive and easily collectable substance that holds great potential as a diagnostic tool in criminal investigations, offering reliable, cost-effective methods to gather key forensic evidence.

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## 1. Introduction

Saliva has been used in criminal investigations as an important biological fluid for identifying suspects, understanding the crime scene, and gathering forensic evidence. It may be considered as a medium of choice of all body fluids in cases of criminal investigation because of its easy availability and cost-effective test methods.<sup>1</sup> Research in this area primarily focuses on how saliva can be analyzed for DNA, trace evidence, and even chemical markers.

## 1.1. Constituents of human saliva

Human saliva is a complex fluid that serves various functions, including lubrication, digestion, and protection of the oral cavity. It is composed of several different constituents, each with its own specific role. The main components of human saliva are:<sup>2-4</sup>

1. **Water:** The largest component of saliva (about 99%), water helps in the lubrication of the mouth and dissolves food particles to aid in digestion.
2. **Electrolytes:** Sodium (Na<sup>+</sup>), Potassium (K<sup>+</sup>), Calcium (Ca<sup>2+</sup>), Magnesium (Mg<sup>2+</sup>), Chloride (Cl<sup>-</sup>), Bicarbonate (HCO<sub>3</sub><sup>-</sup>), and Phosphate (PO<sub>4</sub><sup>3-</sup>) are present to help maintain the pH and ionic balance. These electrolytes also assist in the function of enzymes and the protection of the teeth.
3. **Proteins:** Various proteins in the form of mucins, amylase, lipase, lactoferrin & various immunoglobulins.
4. **Enzymes:** Mainly like salivary amylase & Lingual lipase.
5. **Molecules for defense and healing:** Such as defensins & histatins.

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6. **Urea and ammonia:** These waste products are present in small amounts and are produced as the body breaks down proteins.
7. **Various trace elements:** Includes metals like zinc, copper, and iron.

The composition of saliva can change depending on factors like hydration, diet, individual health conditions, age and gender.

Below are some key studies and uses of saliva in criminal investigations:

### 1.2. DNA profiling

1. **Forensic DNA analysis:** One of the primary uses of saliva in criminal investigations is DNA profiling. Saliva contains cells from the inner lining of the mouth (buccal cells), which can be collected and used to extract DNA for comparison with DNA found at crime scenes. Saliva samples are often found on objects such as cups, bottles, cigarette butts, or in cases where the perpetrator has kissed a victim or left a mark.
2. **Research:** Studies have shown that saliva provides a high-quality source of DNA. Various forensic techniques, including STR (Short Tandem Repeat) analysis, are used to obtain DNA profiles from saliva traces.<sup>5-6</sup>

## 2. Saliva as a Source of Trace Evidence

1. **Chemical signatures:** Saliva can contain a variety of substances, such as drugs, alcohol, hormones, or even toxins. Researchers have investigated how to analyse these chemical markers in saliva to provide insights into a suspect's behaviour, health, or involvement in a crime.
2. **Drugs:** Saliva tests can reveal whether a person has recently used illegal substances, providing evidence of intoxication or impairment.
3. **Alcohol:** Analysis of alcohol in saliva can be used to estimate the blood alcohol concentration (BAC) of a person involved in a crime.
4. **Pheromones or hormones:** These chemicals could potentially offer clues about the emotional state of a suspect, or whether they were under stress or agitated at the time of a crime.<sup>7-9</sup>

## 3. Saliva in Sexual Assault Investigations

1. **Detection of DNA in sexual assault cases:** Saliva left on a victim or a suspect during a sexual assault (e.g., on clothing, the body, or in intimate areas) can provide critical evidence for identifying the perpetrator. Saliva samples are often collected from the victim or the

scene of the crime, and the DNA from these samples is compared to suspects.

2. **Salivary enzymes:** Enzymes in saliva, such as amylase, are also used to identify saliva stains. Forensic labs can detect the presence of amylase, which is produced by salivary glands, to confirm the presence of saliva on evidence.<sup>10-12</sup>

## 4. Forensic Odontology and Bite Mark Analysis

Saliva is sometimes linked with bite marks in cases of assault. Forensic odontologists examine bite marks on the victim's body and compare them with dental impressions of a suspect's teeth, often in combination with DNA analysis of saliva found at the crime scene. Although bite mark analysis has been controversial in the past due to potential for misidentification, it can still be a valuable tool when combined with other forensic evidence.<sup>13-15</sup>

## 5. Molecular and Biochemical Analysis

1. **Proteins and enzymes:** Research has examined the proteins and enzymes found in saliva, such as amylase, lipase, and others, to distinguish human saliva from other biological fluids. Advanced techniques, such as proteomics and mass spectrometry, are being studied for their potential in forensic science to provide more accurate identification from small saliva samples.
2. **Saliva profiling:** Some studies focus on developing profiles of saliva samples to detect patterns that could be unique to individuals, which could further aid in criminal identification and investigation.<sup>16-17</sup>

## 6. Saliva in Postmortem Investigations

In cases of homicide, saliva found on or near the body (on clothing, in wounds, or in surrounding areas) can provide clues to the identity of the perpetrator. Furthermore, saliva may be analyzed for signs of toxins or drugs that could help determine the cause of death.<sup>7,18-19</sup>

## 7. Non-invasive Collection Methods

### 7.1. Saliva collection for suspect elimination

Since saliva can be collected non-invasively, it is often used as an alternative to blood or hair samples. Collecting a suspect's saliva allows investigators to quickly rule out individuals without the need for more invasive procedures.

### 7.2. Oral fluid analysis in drug testing

Saliva is commonly used in drug testing in criminal investigations, especially in cases where immediate results are needed (e.g., roadside drug testing). Researchers continue to refine saliva-based tests for quicker, more accurate detection of controlled substances.<sup>20-21</sup>

## 8. Conclusion

The role of saliva in criminal investigations is multifaceted, from DNA profiling to chemical analysis and trace evidence collection. Ongoing research continues to improve the sensitivity and accuracy of saliva analysis, which aids law enforcement in solving crimes and gathering evidence. Although it is not the only tool available, saliva remains a highly useful resource in forensic science, especially in cases where other biological fluids may be absent or degraded.

## 9. Source of Funding

None.

## 10. Conflict of Interest

None.

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