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DNA Analysis in Criminal Investigations in Burkina Faso, West Africa

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Abstract

Background: In recent years, Burkina Faso has faced increasing insecurity and terrorist attacks. The police, gendarmerie, and justice services are very often in demand to carry out criminal investigations, which are slowed down or incomplete due to the absence of DNA analysis on biological samples from crime scenes and on apprehended suspects. The purpose of this study was to evaluate the contribution of DNA analysis to the resolution of criminal cases in Burkina Faso. **Methodology:** This study was carried out from June 2019 to July 2020. Three (03) crimes were investigated, and DNA analysis was performed on biological samples from the crime scene, suspects, and victims using the AmpFlSTR® identifiler® Direct kit on the ABI 3130 Genetic Analyzer. **Results:** In the explosion case, the alleles found in the victim were the same as those identified in the blood trace from the crime scene. In the armed robbery case, there was a perfect match between the DNA profile of the blood trail and that of suspect 2 for all 15 STRs analyzed. In the murder case, the DNA profile of the murdered man's son and the DNA profile of the biological trace were identical. **Conclusion:** The DNA analyses carried out in criminal cases have identified the perpetrators of the crimes. Their guilt or innocence will be confirmed by the investigators during the interrogations and hearings.

Keywords

DNA, Short Tandem Repeat, Crimes Investigations, Burkina Faso

1. Introduction

Since the development of the first DNA identification analyses by Sir Alex Jeffreys in 1985, DNA analysis remains widely used in law enforcement today. This is because the repetition of DNA sequences varies from person to person, demonstrating the specificity of everyone [1]. Forensic DNA analysis is solicited in several cases, such as parentage tests and human identification in forensics (human remains, clear or incriminate a suspect, etc.) from a biological sample containing DNA [2]-[4].

Most criminal cases require the identification of a suspect from a crime scene sample through a direct comparison process (targeted or database search). Many cases require the identification of human remains, and two approaches impact the selection of the reference sample: direct and indirect comparisons.

Direct comparisons use personal objects or samples believed to be directly from the deceased, such as personal hygiene items (toothbrush, razor, contact lens, etc.) or a medical sample (blood, semen, biopsy, etc.). Indirect comparisons use a parentage or kinship approach requiring careful selection of family members. First-degree relatives (parents, children) are the most reliable choice because they are expected to share half their genome if they are related to the unidentified individual. Although identification can be supported by a single such reference sample, additional samples add statistical weight and should be collected if available [5].

Approximately 99.9 % of the DNA sequence is thought to be identical in all humans, with only about 0.1% variation, and the probability of two non-blood related individuals having the same DNA sequence is about 1 out of 594.1 trillion individuals [6]. Forensic DNA analysis is a real tool in multiple evidence situations and remains a reference in solving forensic cases through the accurate identification of victims, and suspects in some cases [7] [8]. Since 2015, Burkina Faso faced terrorist attacks and increasing criminality. Forensic DNA analysis is not used by the Burkina Police Department during investigations because of the lack of a laboratory for forensic DNA analysis. This situation hampers the progress of investigations, the resolution of criminal cases, and human identification. Forensic DNA analysis is important to improve the identification of victims and investigations [9]. In view of the security situation in Burkina Faso, the availability of forensic DNA tests would help to identify the remains of bodies of soldiers killed on the combat front, create a database of DNA profiles of apprehended terrorists and solve justice cases. This study aimed to evaluate the contribution of forensic DNA analysis in solving criminal cases in Burkina Faso.

2. Methods

2.1. Biological Samples Collection and Processing from Crime Scenes and Suspects

The Police Technique et Scientifique du Burkina Faso Investigated three (3) criminal cases:

The first case: this is an explosion in a courtyard that resulted with sex male

death. A blood sample was taken from the victim and another from a blood trail found at the crime scene using a swab.

Second case: this is an armed robbery that happened in a house with murder. A blood sample was taken from the victim and a blood trail was collected with swabs. After the police investigation, two suspected individuals were identified and their whole blood was collected using EDTA tubes.

Third case: this is a case of the homicide of a father whose son was the main suspect. Blood samples were taken from the victim and the suspected son, and blood trail found at the crime scene was collected with swabs and from the child.

Blood spots were made from whole blood contained in EDTA tubes on FTA paper, while swabs were soaked with deionized water and rubbed on FTA paper. FTA paper is a chemically treated paper matrix for the safe collection, transport and storage of DNA. Punched disks of FTA cards are used directly for PCR amplification according to the manufacturer's instructions.

2.2. PCR Amplification

PCR amplification was performed from 1.2 mm disc (blood-stained disc) obtained by punching on FTA paper previously soaked in blood and containing 5 to 20 ng of DNA. Multiplex PCR amplification of 16 tandem repeat strap loci (polymorphic STR loci) was performed using the AmpFlSTR® identifiler® amplification kit (Applied Biosystems, Foster City, CA, USA) according to the manufacturer's instructions. Among the 16 STRs, the Amelogenin marker was included to allow genetic identification of the sex of each individual. The characteristics of the 16 STRs are shown in Table 1.

PCR was performed in 25 µL of reaction volume containing 5 - 20 ng of DNA, 12.5 µL of primers, and 12.5 µL of Master Mix on the Gene Amp PCR System 9700 thermocycler (Applied Biosystems, USA) according to the following amplification program: initial denaturation at 94˚C for 11 minutes, 28 cycles of 94˚C for 20 seconds, 59˚C for 3 minutes, and 72˚C for 1 minute, and a final extension at 60˚C for 25 minutes.

2.3. Capillary Electrophoresis

The obtained amplification fragments were then analyzed on the ABI 3130 Genetic Analyzer (Applied Biosystem, USA) on a 96-well plate containing 1 µL of PCR product (or allelic ladder), 8.7 µL of Hi-Di Formamide, and 0.3 µL of GeneScan 500 LIZ Size Standard followed by denaturation at 95˚C for 3 min and immediate cooling on ice for 3 min. Electrophoresis was performed using Performance-Optimized Polymer 4 (POP4) with a 36 cm capillary.

2.4. Data analysis

After electrophoresis, GeneMapper® ID version v3.2.1 software was used to assemble the obtained sequences and determine the different genetic profiles.

For each case, we compared the different DNA profiles by looking at the allele

1 and 2 of each locus. DNA profiles are qualified as identical if allele 1 and 1 are identical for all loci.

In the first case: the DNA profile of the victim was compared with the blood trace found at the crime scene.

In the second case: two comparisons were made: between the genetic profile of the victim and that of the blood trace, between the genetic profile of the victim and those of the two suspects.

In the third case: the genetic profile of the victim (father) was compared to the biological trace and to the son.

2.5. Ethics Approval

This study was approved by the Institutional Ethics Committee of CERBA/LABIOGENE and The Tribunal de Grande Instance de Ouagadougou (Deliberation N˚ 2019-19/III-015) and conducted according to the Declaration of Helsinki. Also, written informed consent was obtained before blood collection.

Table 1. STR loci and alleles with their characteristics.

Locus	Location on the chromosome	Included alleles	Fluorochrome
D8S1179	8	8, 9 10, 11, 12, 13, 14, 15, 16, 17, 18, 19	6-FAM
D21S11	21q11.2-q21	24, 24.2, 25, 26, 27, 28, 28.2, 29, 29.2, 30, 30.2, 31, 31.2, 32, 32.2, 33, 33.2, 34, 34.2, 35, 35.2, 36, 37, 38	
D7S820	7q11.21-22	6, 7, 8, 9, 10, 11, 12, 13, 14, 15	
CSF1PO	5q33.3-34	6, 7, 8, 9, 10, 11, 12, 13, 14, 15	
D3S1358	3p	12, 13, 14, 15, 16, 17, 18, 19	VIC
TH01	11p15.5	4, 5, 6, 7, 8, 9, 9.3, 10, 11, 13.3	
D13S317	13q22-31	8, 9, 10, 11, 12, 13, 14, 15	
D16S539	16q24-qter	5, 8, 9, 10, 11, 12, 13, 14, 15	
D2S1338	2q35-37.1	15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28	
D19S433	19q12-13.1	9, 10, 11, 12, 12.2, 13, 13.2, 14, 14.2, 15, 15.2, 16, 16.2, 17, 17.2	NED
vWA	12p12-pter	11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24	
TPOX	2p23-2per	6, 7, 8, 9, 10, 11, 12, 13	
D18S51	18q21.3	7, 9, 10, 10.2, 11, 12, 13, 13.2, 14, 14.2, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27	
Amelogenin	X: p22.1-22.3 Y: p11.2	X, Y	PET
D5S818	5q21-31	7, 8, 9, 10, 11, 12, 13, 14, 15, 16	
FGA	4q28	17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 26.2, 27, 28, 29, 30, 30.2, 31.2, 32.2, 33.2, 42.2, 43.2, 44.2, 45.2, 46.2, 47.2, 48.2, 50.2, 51.2	

3. Results

3.1. Explosion

The genetic analysis shows a perfect match between the genetic profile of the victim and that of the blood trace found at the crime scene. Indeed, for all 16 STR loci, the alleles found in the victim are the same as those identified in the blood trace from the crime scene (Table 2).

Table 2. Comparison of the victim's DNA profile (Explosion) with that of the blood trail.

Locus	Victim		Blood trail	
	Allele 1	Allele 2	Allele 1	Allele 2
CSF1PO	8	12	8	12
D13S317	8	10	8	10
D16S539	9	10	9	10
D18S51	14	15	14	15
D19S433	11	14	11	14
D21S11	23.2	24	23.2	24
D2S1338	17	19	17	19
D3S1358	12	14	12	14
D5S818	8	9	8	9
D7S820	9	13	9	13
D8S1179	9	12	9	12
FGA	19	20.2	19	20.2
TH01	7	9	7	9
TPOX	8	9	8	9
VWA	10	13	10	13
AMEL	X	Y	X	Y

3.2. Armed Robbery

In this criminal case, the comparison of the victim's DNA profiles with the blood trace found at the crime scene showed no match for any of the 16 STRs. The forensic DNA profile from the blood trail also did not match that of suspect 1. However, there was a perfect match between the DNA profile of the blood trace with that of suspect 2 for all 16 STRs analyzed (Table 3).

3.3. Murder

In this murder situation, the genetic profile of the son of the murdered man and that of the sampled biological trace are identical. Also, the comparison of the

genetic profile of the killed man with that of the suspected son shows that one of the alleles in the son comes from the father (killed man) for all 16 STR. The other allele was definitely from the mother (Table 4).

Table 3. Comparison of the DNA profiles of the victim, the blood trail, and the two suspects.

Locus	Victim		Blood trail		Suspect 1		Suspect 2	
	Allele 1	Allele 2	Allele 1	Allele 2	Allele 1	Allele 2	Allele 1	Allele 2
CSF1PO	12		11	13	10	12	11	13
D13S317	11	12	8	12	12	13	8	12
D16S539	9	11	9	11	11	12	9	11
D18S51	18		15	17	12	18	15	17
D19S433	11	13	10	11	12.2	13.2	10	11
D21S11	30		28	29	30	31.2	28	29
D2S1338	19	22	19	22	19	23	19	22
D3S1358	14	16	16	15	14	16	16	15
D5S818	12	13	11	12	8	12	11	12
D7S820	10	11	8	10	8		8	10
D8S1179	11	13	15	16	8	9	15	16
FGA	21	23	23	24	20	23	23	24
TH01	7	8	7	9.3	7		7	9.3
TPOX	7	8	9	11	6	7	9	11
VWA	12	19	16	17	16		16	17
AMEL	X	Y	X	Y	X	Y	X	Y

Table 4. Genetic profiles of the killed man, the blood trail, and the son of the killed man.

Locus	Killed man		Blood trail		Son of the killed man	
	Allele 1	Allele 2	Allele 1	Allele 2	Allele 1	Allele 2
D8S1179	10	13	13	14	13	14
D21S11	29	30	27	29	27	29
D7S820	10	11	9	10	9	10
CSF1PO	11		10	11	10	11
D3S1358	16	17	13	17	13	17
TH01	7	8	7		7	
D13S317	11	12	11	12	11	12

Continued

D16S539	10	11	9	11	9	11
D2S1338	17	25	24	25	24	25
D19S433	14	15	12	14	12	14
VWA	16	20	16	20	16	20
TPOX	8	10	9	10	9	10
D18S51	15	19	12	19	12	19
D5S818	12	14	12		12	
FGA	24	26	24		24	
Amel	X	Y	X	Y	X	Y

4. Discussion

In this study, we were able to analyze and compare DNA profiles of biological samples from crime scenes and suspects using forensic DNA analysis. The probability of two non-blood related individuals having the same DNA sequence is about 1 in 594.1 trillion individuals [6].

In the blast case, forensic DNA analysis established a perfect match between the victim's DNA profile and the blood trace found at the crime scene. This match confirms that the blood trace is that of the victim and not of another person. In fact, in the case of human remains identification, it is possible to make a direct and indirect comparison. The direct approach involves comparing the deceased's sample with a sample believed to have come from or been used by the deceased. An indirect approach uses close family members to make an identification. Both methods can provide very strong DNA evidence to support identification [5].

In the case of the armed robbery, we determined the DNA profiles of the victim, blood trail, and suspect samples. First, we compared the DNA profile of the victim with the DNA profile of the blood trail. This first comparison was to determine who the blood trail belonged to. The comparison showed a mismatch between the two DNA profiles. Indeed, the alleles for each STR marker in the victim were different from those in the blood sample. This mismatch allowed us to conclude that the blood sample was not the victim's but could belong to the perpetrator. Forensic investigations led to the identification of two suspects. Their genetic profile was determined and then compared to one of the blood traces. As a result, we observed a perfect match between the genetic profile of suspect n˚2 and the blood trace. This allows us to say that he would be present at the time of the crime.

In the murder case, the crime scene technicians collected biological traces at the crime scene. The analysis of these traces in the laboratory allowed the identification of another DNA profile in addition to the victim's DNA profile. The comparison of the two DNA profiles showed a familial link between the victim's DNA profile and the biological trace found at the scene. With the authorization of the court, a

blood sample was taken from the victim's son to compare his DNA profile with that of the biological trace. Indeed, there was a perfect match between the DNA found at the crime scene and that of the son. The son was therefore the author of his father's murder. At a crime scene, bloodstains, semen, other biological traces, or the victim's body are often found and each of these elements can be used as evidence. The forensic scientist then uses the evidence at hand to link the case to the arrested suspect by matching the traces to the suspect, using DNA profiling [10]. In Nigeria, in one case, there was a 100% match between the DNA recovered from the various materials found at the crime scene (rope and gloves) and the suspect's DNA sample collected by buccal swab after the 15 STR loci were examined [4].

Forensic DNA analysis provides evidence that can be used to convict criminals, irrefutable evidence of wrongful convictions, valuable links to actual perpetrators, and could also deter some offenders from committing more serious offenses [11]. Also, DNA has the power not only to convict the guilty, identify the dead and resolve questions of parentage but also to exonerate the innocent [9]. This means that today, DNA analysis remains a must in forensic investigations. It could be used to solve even unsolved criminal cases dating back several years. Indeed, forensic DNA analysis can be performed on human remains (bones, skeletons, skulls, etc.), tissues, etc. In this case, mitochondrial DNA would be the best choice because of its resistance. For heavily degraded samples or on hair without a bulb, it is sometimes impossible to obtain a complete profile of all microsatellites. In this case, mitochondrial DNA can be used because there are many copies of mitochondrial DNA in a cell, whereas there are rarely more than 1 or 2 copies of nuclear DNA.

Nowadays, NGS (next-generation sequencing) technology provides further innovation for highly degraded biological traces for which even extremely partial DNA profiles can be obtained [3] [12]. In addition to paternity testing and forensic DNA analysis cases, DNA fingerprints can also be used to elucidate cases such as identity theft, recognition, the establishment of civil status, maternity research, sibling research, etc. [13] [14].

In some situations, forensic DNA analysis cannot be used as irrefutable evidence to conclude that a suspect is guilty. In these cases, the investigation should be completed with interviews of the suspect(s), neighborhood, friends, colleagues, etc., to better understand the circumstances of the crime. The facts are also other factors that can help investigators confirm the guilt or innocence of a suspect or suspects. Not every biological trace of an individual at a crime scene makes him or her the perpetrator of the crime. During crime scene investigations, technicians collect any biological trace (blood, hair, etc.) or used objects (knife, glass, cigarette butt, personal items, etc.) that may be a source of DNA [15] [16]. The goal is to not miss any evidence that could help identify perpetrators.

From all these criminal cases, we can say that forensic DNA analysis plays a crucial role in criminal investigations. It is therefore important that specialized

services of the police, gendarmerie, or even centers or institutes at the national level have the human, material, and technical means to carry out DNA tests to fight against major crimes (murders, armed attacks, terrorism, etc.).

5. Conclusion

In this study, we were able to show the important role of forensic DNA analysis in the context of Burkina Faso for human identification in forensics. Indeed, any biological trace left on a crime scene is a source of DNA. It helps to advance investigations very quickly. Because of the worrying security situation, Burkina Faso should introduce forensic DNA analysis into the daily investigations of the police or the gendarmerie to facilitate investigations or the judgment of certain cases by the courts.

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Conflicts of Interest

The authors have no relevant financial or non-financial interests to disclose.

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