Research Article

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The Position of Forensic DNA Database in Criminal Investigation: Understanding the Utilization in Africa, Particularly Nigeria a Review

***Nwawuba Stanley Udogadi, [a]Okechukwu Francis Chibuike, [b]Momoh Sunday Maliki, [c]Nwokolo Chris Chinedu, [d]Ojo Osas Godfrey, [e]Akhigbe-Oboh Larry Osazee, [f]Okporu Onome Jacinta Oghale, [g]Bini Nathaniel Ewere**

**defgCentre for Forensic Programmes and DNA Studies, University of Benin, Benin City, Nigeria*

[a]Department of Biochemistry, School of Life Science, Hemwati Nandan Bahuguna Garhwal University Shrinager, Uttarakhand, India

[b]Department of Chemical Pathology, School of Medicine, University of Benin

[c]Edo State Command, Police State Headquarters, Benin City, Nigeria.

[g]Medical Laboratory Services, Central Hospital Warri

[*]Corresponding author
Nwawuba Stanley Udogadi, Centre for Forensic Programmes and DNA Studies, University of Benin, Benin City, Nigeria

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Abstract

Forensic DNA databases constitute a central investigative resource in modern-day criminal justice systems, and agrees to a "conservation of resources", by expediting the resolution of crime and judicial proceedings via consolidating the evidence or introducing plea bargaining. Quite a number of reports have demonstrated the efficiency of the DNA database in assisting criminal investigation around the world. However, studies are still lacking in Africa, particularly Nigeria on the utilization of DNA database in crime investigation. Therefore, this article provides a first-hand report. In conducting this study, a comprehensive electronic literature search using PubMed, ScienceDirect, Google Scholar, and Google search for similar and related works were used, and all works meeting the subject matter were considered, including; reviews, meta-analyses, retrospective studies, observational studies, organization recommendations, and original articles. Remarkably, the peculiarity of the various forms of crime committed in Nigeria tends to involve or leave behind biological evidence at the scene of a crime. This biological evidence is a key sample for DNA profiling and subsequent storage in a forensic DNA database. Therefore, a National DNA Database has become very necessary in Nigeria.

Keywords: Forensic DNA Database, Forensic DNA Profiling/Fingerprint, Forensic DNA Database in Nigeria, Forensic DNA Evidence, and Criminal Investigation in Nigeria.

Introduction

This article examines the DNA database, focusing on Africa, but also drawing on examples from the United Kingdom, the United States, and other countries with an operational DNA database. Going forward, a prelude on the delineation of crime would be instructive. Based on vicissitudes in political, social, religious, psychological, and economic settings globally, it is assumed that there is no generalized delineation of crime [1]. An act considered as a crime in one setting, may not necessarily be a crime in another setting, and as a result, the perception of an "act" to be a crime differs with time and space [1, 2]. Summarily, crime is an illegitimate act punishable as stated by a state's jurisprudence, and it is considered as one of the human security problems confronting humanity across the world [3].

The rising incidence of various forms of crimes and the struggle to grapple crimes has led to an adoption of several approaches towards criminal investigations. In the light of this, a body of evidence has demonstrated that forensic DNA databases decrease crime rates, assist criminal investigators to establish links between a particular suspect of a specific crime and other unsolved crimes, or can offer support to identify possible suspects while clearing

other suspects in the early stages of an investigation especially in categories where forensic evidence is likely to be collected at the scene of a crime, for example, murder, rape, assault, and robbery [4-7]. The use of DNA in support of the investigation of crime is said to have been the most significant progression in forensic science since the introduction of DNA fingerprinting in the 19th Century [8]. It has been reported that DNA evidence is granted a transcendent, epistemic status and as such, it is extensively admissible in many courts around the world.

Forensic DNA databases have proved to be an indispensable tool in preventing miscarriages of justice and deterring offenders from further criminal activity [9-11]. Thus, the national DNA database (NDNAD) is presently an established part of the police investigation in the US, UK, Canada, England & Wales, and several European countries including The Netherlands, Austria, Germany, Finland, Norway, Denmark, Switzerland and Sweden, and others have successfully introduced national databases holding the DNA profiles from suspected and convicted criminal offenders as well as from biological stain materials from unsolved crime cases [8, 12-15].

In Africa, commendable progress has also been made, particularly in South Africa. Ever since the introduction of the Criminal Law (Forensic Procedures) Amendment Act (2013), the use of DNA profiling technology became the gold standard for a criminal investigation in south Africa, and as such, the Forensic DNA Database was developed [16, 17]. Other Africa countries including Egypt, Morocco, Namibia, Botswana, and Sudan have also demonstrated awareness on the important position of forensic in their respective criminal justice system and therefore operate a DNA database. It is rather ill-starred that, Nigeria does not currently hold a National Forensic Database despite the reported prevalence of crime [18]. Remarkably, the peculiarity of the various forms of crime committed in Nigeria tends to involve or leave behind biological evidence at the scene of a crime. This biological evidence is a key sample for DNA profiling and subsequent storage in a forensic DNA database. Therefore, a national DNA database has become very necessary in Nigeria.

Methods

The present narrative review was carried out by a comprehensive electronic literature search using PubMed, Science Direct, Google Scholar and Google Search. The following keywords and their combinations were used; Forensic DNA Database, Forensic DNA Profiling/Fingerprint, Forensic DNA Database in Nigeria, Forensic DNA Evidence, and Criminal Investigation in Nigeria, Criminal Justice System. All works relevant to the subject matter were considered, including reviews, meta-analyses, organization recommendations and original articles. Preference was placed on the most recent papers but did not exclude commonly cited and highly regarded older publications.

Crime Prevalence

Premised on vicissitudes in political, social, religious, psychological, and economic settings globally, it is assumed that there is no generalized delineation of crime [1]. An act considered a crime in one setting, may not necessarily be a crime in another setting, and as a result, the perception of an "act" to be a crime differs with time and space [1, 2]. In light of this, of course, they are several reported definitions of crime. Oguntunde et al. (2018) considered crime to be an act that results to offenses that are punishable by the law guiding the society, UN-Habitat (2007) defined crime as an antisocial act that violates a law and for which punishment can be imposed, from the perspective of Perry (2009), crime is considered as an offense that are committed against the citizenry of a country or events and actions that are prescribed by the criminal law of a particular country, and according to Adewumi et al. (2014), section 2 of the Nigeria Criminal Code defines crime as an act or omission which is rendered punishable by some legislative enactment [18-21].

Crime is a universal concern and a major security challenge confronting society. Over time, countries around the world have struggled to contain the rising incidences of various forms of crimes including homicide, armed robbery, and kidnap, drug trafficking, sex trafficking, illegal gun-running, and a host of others [3]. However, in the setting of Nigeria, the predominant nature of a crime against humanity includes rape, kidnapping, murder, burglary, fraud, terrorism, and robbery [18].

More than a few numbers of reports and studies have demonstrated a remarkable increase in criminal activities in Nigeria [22, 23]. According to the report of Adewumi et al. (2014), Nigeria is considered among the leading countries for a sizable network of organized crime, and a heightened national security challenge [21]. Additionally, reports have it that Nigeria is also one of the leading countries in the world with the highest crime rates, and over the years, the increased incidence of crime has been revealed to be perpetrated with an organized and sophisticated approach [1].

Furthermore, it has been reported that no zone in Nigeria is immune to crime, and the upsurge of crime has been ongoing as far back as the 1980s [3]. The upsurge of crimes and its ravaging effects have been felt like a tsunami in the society with a climate of dreads and apprehensions about public safety [3]. In this light, several factors have been fingered as determinants for the growing rate of crime in Nigeria including poverty, social exclusion, unemployment, education, inadequate crime control model of national security, and a host of other economic and socio-demographic factors that influence the mind and behavior of individuals in making decisions among others [24, 3, 22].

In relation to economics viewpoints, adopting a crime equation of a pooled dataset from 2002 to 2005, a pooled ordinary least square and pooled EGLS for assessing the demographic and socio-economic determinants of crimes in Nigeria as demonstrated by the study of Omotor (2010) revealed that, lagged crime rate, per capita income and population density are significant and positively correlated to all forms of crimes in Nigeria [22]. In the same light, a criminal is presumed to be a rational being who perpetrates crime as a result of the benefits to be received from the act which always outweighs the costs. Implying that individuals indulge in criminals acts because the probable monetary and non-monetary benefits are greater than the costs associated with the crime [25].

Numerically, the report of the United Nations Office on Drugs and Crime in 2011 at 468,000 estimated global homicides, more than a third (36%) was estimated to have occurred in Africa,

31% in the Americas, 27% in Asia, 5% in Europe and 1% in the tropical Pacific region [26]. Africa has been demonstrated to be the leading continent in global crime statistics particularly, Nigeria [18]. Going forward, Crime Statistics by the National Bureau of Statistic statement on reported offenses in Nigeria, revealed that a total of 125,790 cases were reported in 2016 and offense against persons recorded 45,554 cases [27]. Offense against persons includes murder, manslaughter, rape, and other physical abuse [27]. According to the data reported by Omotor (2010) on murder cases, there was a phenomenal increase of over 75 percent between 1994 and 2003 and these figures are worrisome [22]. Remarkably, the peculiarity of the various forms of crime committed in Nigeria tends to involve or leave behind biological evidence at the scene of a crime. These biological shreds of evidence are a key sample for DNA profiling and subsequent storage in a forensic DNA database. Therefore, a national DNA database has become very necessary in Nigeria.

Table 1: Crime Prevalence in Nigeria in comparison to related Countries.

Country	Crime Level (World Rank) n=132	Murder Rate (World Rank) n=132	Violent Crimes; assault and armed robbery (World Rank) n=132	Property crimes; vandalism and theft (World Rank) n=132
Nigeria	7th	5th	7th	8th
Egypt	32nd	26th	32nd	62nd
South Africa	6th	3rd	5th	7th
Morocco	15th	37th	7th	17th
Namibia	22nd	47th	46th	36th
Botswana	10th	54th	9th	6th
Sudan	86th	18th	81st	68th

The data shown in table 1 provides insight into criminal activities in Nigeria in comparison with some selected Africa countries. The inclusion criteria were based on the fact that the aforementioned countries in recent time were enlisted among the 69 countries that hold an operational forensic DNA database as reported in the study of, and these countries are located within the same continent with Nigeria as revealed in figure 1 [28, 29]. The data provided in table 1 was sourced from a survey study conducted by Nation Master from July 2011 to February 2014 with a target population of 132 countries [30]. The data presented in Table 1 revealed that aside from Republic of South Africa, crime level including violent crimes and property crime were predominant in Nigeria vis-à-vis the rest of the countries. Despite the comparatively low level of crimes in Egypt, Morocco, Namibia, Botswana, and Sudan to Nigeria, the aforementioned countries have demonstrated awareness of the important position of forensic in their respective criminal justice system and therefore operate a forensic DNA database for criminal investigation. Evidentially, Nigeria, a country regarded as the foremost populous, and one of the largest economies according to IMF, 2019, should as a matter necessity consider holding a forensic DNA database to boost the fight against the upsurge of various forms of crimes against human presently ravaging the society.

An insight into the position of Forensic DNA Database in Criminal Investigation

A forensic DNA database is a computer database containing records of DNA profiles primarily for the purpose of systematic comparison, and matching with a scene of crime sample or individual profile [31, 32, 11]. The expediency that genetic information has provided and continues to provide when concerned with identification purposes, is one that cannot be ignored [33]. As at the end of 1999, four years after the establishment of the first DNA database in the UK in 1995, the database had entries of personal profiles well over 700, 000, and it was not a shock that there were about 700 matches achieved each week [14]. As of June 2011, the US Federal DNA database Combined DNA Index System (CODIS) has aided in over 141,300 investigations in the USA by more than 147,200 hits produced [34]. Similarly, the report of the Federal Bureau of Investigation FBI- NDIS Statistics (2019) revealed that the National DNA Index System (NDIS) contains over 13,973,206 offender profiles, 3,721,360 arrestee profiles, and 973,108 forensic profiles as of September 2019 [35]. Since, the success of the DNA database (CODIS) was ultimately going to be determined by the number of crimes it aids in solving, of course, CODIS did produce over 485,063 hits, assisting in more than 474,576 investigations as of September 2019 [35, 30]. In the same light, the report of the Federal Bureau of Investigation on federal DNA database (2019), as available on the 30th October 2019, validates the position of forensic DNA database in solving crime and supporting investigation via hit confirmation against stored DNA profiles in the National DNA Index System (NDIS) [36, 30].

A body of evidence has continued to emerge demonstrating that extensive forensic DNA databases decrease crime rates, assist criminal investigators to establish links between a particular suspect of a specific crime and other unsolved crimes, or can offer support to identify possible suspects while clearing other suspects in the early stages of an investigation especially in categories where forensic evidence is likely to be collected at the scene of a crime, for example, murder, rape, assault, and robbery [4-7]. The use of DNA in support of the investigation of crime is said to have been the most significant progression in forensic science since the introduction of fingerprinting in the 19th Century [8], and Forensic DNA databases have proved to be an indispensable tool in preventing miscarriages of justice and deterring offenders from

further criminal activities [8-10].

In contemporary criminal justice systems, forensic DNA databases remain a veritable tool. According to Jakovski et al. [2017], back-of-the-envelope estimated that the marginal cost of preventing each crime, suggests that DNA databases are much more cost-effective than other common law enforcement tools [31]. As well, forensic DNA databases agree to a "conservation of resources", either by expediting the resolution of crimes or by accelerating the judicial processes [37]. Additionally, the DNA database confers enormous benefits in efficiently and effectively solving crimes, and exonerating the innocent, and the incredible power of DNA technology as an identification tool brought an incredible change in the criminal justice system [6, 7]. Consequently, many countries around the world now operate forensic DNA-databases to identify owners of crime-related stains [38]. Presently, it is reported that around 69 countries operate national forensic DNA databases, and others are being expanded or established in at least 34 additional countries [28, 29]. Figure 1, shows the Africa countries among the 69 that holds a forensic DNA database.

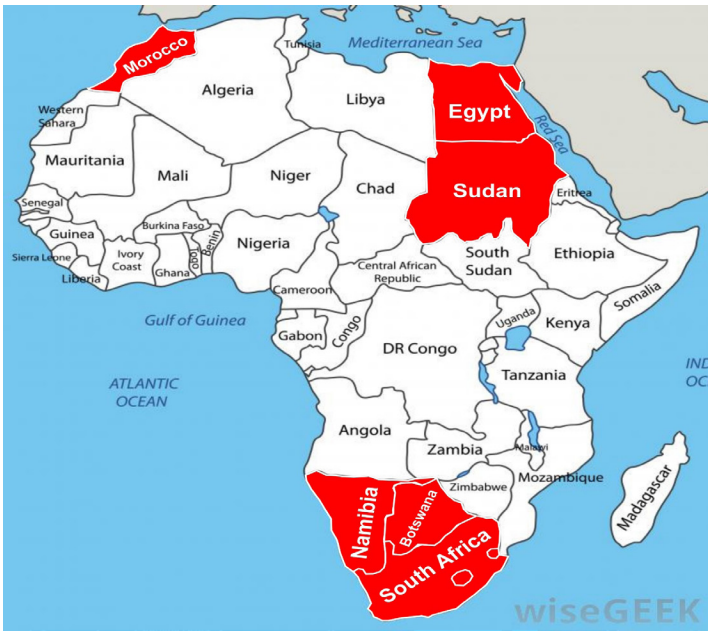

Figure 1: Map of Africa showing countries with a DNA Database (highlighted in red)

Table 2: Showing Africa countries conducting DNA Profiling

Country	Nominal GDP ($ billions)	DNA Profiling	Reference DNA Profile (DNA Databank)	References
Nigeria	444.916	√ (2017)	X	[39-41]
South Africa	371.298	√ (1998)	92,871	[39, 42-44]
Egypt	299.589	√ (2002)	1046	[39, 45, 46]
Morocco	121.35	√ (2004)	X	[39, 47]
Kenya	99.246	√ (2008)	X	[39, 48]
Angola	92.191	√ (2008)	X	[39, 49]
Ethiopia	90.968	√ (2012)	X	[39, 50]
Ghana	68.258	√ (2011)	X	[39, 51]
Tanzania	61.032	X	X	[39]
Botswana	19.651	√ (1989)	3500	[39, 52, 53]

Abbreviations denotes: X: Absent, Present: √

As demonstrated in Table 2, ten African countries were selected; nine of which were selected based on international monetary fund ranking for Gross Domestic Product (GDP), and the other, Botswana, selected because DNA profiling and DNA database are in part used for identification purpose. GDP provides a snapshot of a country's economy size and growth rate; thus, Africa's biggest countries were selected [39]. The following African countries possess the capacity to conduct DNA profiling, including South Africa, Egypt, Morocco, Kenya, Angola, Ethiopia, Ghana, and Botswana (Table 2). In the case of Nigeria, samples collected concerning criminal investigations are sent overseas for DNA profiling.

Case Report where forensic DNA database would have aided criminal investigation in Nigeria.

Case Report I

In one of the cities in Nigeria on June 05, 2020, a 22-year-old lady was found lying half-naked in a pool of blood at the quiet nearby church where she went to study [40-53]. The church security guard was the first to find out about the situation and a report was made. Following the report at the nearby station, police officers responded. After careful observation, she was immediately rushed to the hospital where she revealed that she was beaten and raped by unknown men in the church before she passed on. A search was conducted at the crime scene and multiple items were found

including a fire extinguisher with bloodstains, a table, chairs, and study materials. According to reports, the police recovered fingerprints from the fire extinguisher, and some suspects were arrested [54, 55]. However, this case remains unsolved.

Forensic DNA profiling/database would have assisted in solving the crime stated as case report I. Forensic crime investigations somewhat relies on Locard's Exchange Principle, "every contact leaves a trace". In this case, biological pieces of evidence including either blood, saliva, fingernails, hair, semen, or vaginal swab would have been collected from the victim, crime scene, and the suspects. Maintaining a chain of custody, the sample collected transported to an operational DNA laboratory for DNA profiling. The profiled samples would then be compared for a match and used as evidence to either convict or exonerate the suspect. Finally, the suspect DNA profile can then be stored in a DNA database for a possible match at the instance of a related crime.

Reported cases resolved with DNA Profiling/Database

Case Report II

As reported by Jakovski et al. [2017], an old woman was found dead in her bam, and an investigation was conducted to identify the culprit. In the course of the investigation, some items were found at the crime scene including a cigarette filter and a bottle of coke, which were collected for DNA profiling. Blood and nail debris from the victim were collected during the autopsy and were also sent for DNA profiling. The analysis was conducted; Qiagen mini kit was used for extraction, Identifier Amp Kit with polymerase chain reaction (PCR) was used for amplification, and capillary electrophoresis was conducted on 310 Genetic analyzer was used for DNA profiling. The DNA profiles from the cigarette filter and the bottle of coke were identified, however, it was that of an unknown male (suspect). The unknown male DNA profile was then sent to the Macedonian National DNA database for comparison and possible hit. Eventually, the was a hit, and this time, a positive match with a prisoner convicted for drug trafficking, who was in that period released for the weekend [31].

Table 3: DNA Profiles from the victim, suspect and, collected items.

Locus	Repeat Motif	Victim	Coke Bottle	Cigarette Filter	Suspect
D8S1179	compound TCTA/TCTG	14, 14	12, 14	12, 14	12, 14
D21S11	complex TCTA/TCTG	28, 29	28, 29	28, 29	28, 29
D7S820	simple GATA	9, 11	8, 8	8, 8	8, 8
CSF1PO	simple AGAT	11, 12	11, 11	11, 11	11, 11
D3S1358	compound TCTA/TCTG	15, 19	15, 18	15, 18	15, 18
TH01	simple TCAT	8, 8	9, 9.3	9, 9.3	9, 9.3
D13S317	simple TATC	12, 14	11, 14	11, 14	11, 14
D16S539	simple GATA	11, 11	10, 11	10, 11	10, 11
D2S1338	compound TGCC/TTCC	23, 24	18, 24	18, 24	18, 24
D19S433	simple AGAA	13, 15	14, 15	14, 15	14, 15
vWA	compound TCTA/TCTG	17, 17	16, 18	16, 18	16, 18
TPOX	simple AATG	9, 11	8, 11	8, 11	8, 11
D18S51	simple AGAA	13, 16	14, 16	14, 16	14, 16
D5S818	simple AGAT	11, 11	12, 12	12, 12	12, 12
FGA	compound CTTT/TTCC	21, 22	21, 24	21, 24	21, 24
Amelogenin		XX	XY	XY	XY

Adopted from [31] with slight modifications

Case Report III

Officers responded to a report of gunfire to search out a 35-year-old male shot dead in his backyard in an urban neighborhood. A subsequent police search of the area found the presence of several items of evidence, including a handgun, a pair of work gloves, and two shirt sleeves (often utilized as face masks), discarded in a nearby alleyway. DNA was extracted from the items collected and profiled. A comparison of the profiled DNA from the items of evidence to the DNA profile stored in CODIS produced a hit. The matched DNA profile was then used as evidence against the suspects, arrested and charged with felony, murder, attempted robbery, and he was sentenced to 65 years in prison [56].

Forensic DNA Evidence and the Criminal Justice System Globally

The key breakthrough that revamped the criminal justice system and strengthened the use of DNA profiling in crime investigation, was the work of Dr. Alec Jeffreys in 1985. Using DNA profiling, Dr. Alec Jeffreys was able to identify the real culprit of the rape and murder case of 15-year-old Dawn Ashworth in Leicestershire,

England [57, 58, 30]. Richard Buckland was arrested as a suspect, and had already confessed to Ashworth's murder. However, the analysis of the DNA samples from the 1983 and 1986 crimes did not match Richard Buckland's. Eventually, Colin Pitchfork was arrested and his DNA profile matched the crime scenes samples. Based on the DNA evidence, he was convicted and sentenced to life in prison [58, 30].

Ever since the conviction of Colin Pitchfork using DNA as evidence, its admissibility and use in many courts around the world have continued to grow, and its regarded as a gold standard in criminal investigation [59, 60]. In the light of this, a functioning alliance between the judicial arm and forensic scientists remains central for strengthening the position of forensic evidence in criminal proceedings [61]. Therefore, legal practitioners have gradually taken a more critical approach in examining the way forensic evidences are introduced at trials [62]. Given this, the methodologies and underpinning science for providing DNA evidence; DNA profiling, is reliable, reproducible, accurate, and based on validated technology and techniques for both the generation of a DNA profile and the interpretation of that profile [57].

Forensic DNA evidence assumes an important position in respect to abating criminal activities in the criminal justice system. Evidences have emerged demonstrating that Forensic science and the law epitomizes interdisciplinary epistemologies, and as such quite several empirical studies, reported high profile cases [62-64], and evidences from around the world have expressly revealed that progression in forensic science expedites the administration of justice [30, 65].

The adoption of forensic science approach towards criminal investigation is a routine in the developed countries, and the use of forensic evidence to aid gamut of activities in the criminal justice system have been recognized worldwide [65]. In England and Wales, to a certain degree, a laissez-faire approach to the admissibility of forensic evidence has been demonstrated, and it is reported that forensic evidence is rarely considered inadmissible except for a stark inappropriateness [63]. In the U.S. courts have positioned 'DNA' evidence in an exceptional epistemic space [66], and in Belgium, the only justification for refusal of forensic evidence is on the account that the criminal dossier already holds enough evidence to make an appropriate pronouncement; in consequence, any additional forensic expert evidence is considered superfluous [67].

Despite the transcendent, epistemic status granted to DNA evidence, pitfalls and challenges have also been recognized vis-à-vis the introduction of forensic evidence in the courtrooms [66, 62]. Some of the central challenges range from an inappropriate chain of custody, the investigative methodology in the laboratory setting, the manner in which the evidence is presented at trials, its interpretation and evaluation within a case context, and its contribution in convictions or acquittals once admitted [66, 63].

Forensic evidence and the Nigeria Criminal Justice System

The underpinning contribution of forensic evidence to the criminal justice system cannot be undermined. To ensure an evidential modern approach to solving crimes, a partnership between the law of science and the law of justice must maintain a powerful relationship [68]. However, the judicial approach towards forensic evidence in Nigeria has largely been reported to be indifferent, and the present situation is in part due to the paucity of knowledge on forensics [68]. Extensive evidence has revealed that the outmoded model of the criminal investigation remains prominent in Nigeria. The Nigeria Police Force has continued to be dependent on circumstantial evidence, eye witness testimonies, interrogation, and confessional statements [65].

A prelude to the role of the court and the police in Nigeria Criminal Justice System will be instructive. The Nigeria Police is, by the law, saddled with the onerous responsibility of criminal investigation, and in respect of the Nigeria Criminal Justice System, the Police are considered as the gatekeeper since the police institutes criminal cases, summons, arrests, and also detains [69]. On the other hand, the courts in Nigeria epitomizes the judiciary arm and about the constitution of Nigeria, the court is responsible for safeguarding fair dispensation of justice based on the evidence before it [70].

In Nigeria, forensic evidence has not been placed in an exceptional epistemic space, and till present, no law has expressly provided for the application of forensic science in a criminal investigation [71, 65]. However, in practice, the Nigerian courts are placed in a position to accept evidence relating to the use of scientific evidence, and the person empowered to present such evidence is regarded as an expert witness [72]. According to the reports of [72-74], as a rule in Nigeria, opinions of witnesses are generally inadmissible in court trials as contained in section 67 of the Evidence Act 2011 [74]. However, there is an exception to the general rule provided for under section 68 of the Evidence Act 2011 which states thus; "when the court has to form an opinion upon a point of foreign law, customary law, or custom, or of science or art or as to the identity of handwriting or finger impressions, the opinions upon that point of persons specially skilled in such foreign law, customary law, or custom or science or art or in questions as to the identity of handwriting or finger impressions are admissible." "Persons so specially skilled as mentioned in subsection (1) of this section are called experts" (Evidence Act 2011, s 68). In furtherance to the above, the court will customarily accept evidence of an expert witness except such evidence is contrary to common sense or perverse [72].

Based on operationalization and functionality, the Lagos State DNA and Forensic Center (LSDFC) laboratory commissioned in 2017 is largely reported as the only fully accredited and operational Forensic DNA Laboratory in Nigeria [41]. Up until 2019, LSDFC was reported to have assisted in 85 criminal investigations and 191 relationship cases including disaster victim identification and paternity and maternity disputes [41]. The dearth in knowledge and technical know-how on forensic DNA practice in Nigeria could be impugned on the paucity of research and training facilities in the country. Owing to this, a statistical overview of training capacity will be instructive. Presently, of the over 250 licensed tertiary educational institutions in Nigeria, none of them runs a program in any field related to forensic sciences at the undergraduate level [65]. However, at the postgraduate level, the Centre for Forensic

Programmes and DNA Studies, the University of Benin remains the only center that provides training on Forensic DNA. Finally, the non-application of forensic science to criminal investigation practically renders the criminal justice system incompetent and this is seeing as the case of Nigeria [65, 68].

Legislation and regulation of forensic DNA profiling/ Database in African

The legislative provision that allows for the collection of samples for DNA profiling from an individual during a criminal investigation and the retention of the profile generated on DNA database varies from country to country [8]. In furtherance, the objective of the legislative provision is to ensure that the right and civil liberty of citizens are protected, as well as maximizing the benefit of genetic technology for criminal investigation [13, 8].

Going forward, in South Africa, forensic DNA evidence is regarded as the gold standard for the administration of justice. Thus, the Criminal Law (Forensic Procedures) Amendment Act (2013) expressly provides a definition, obtaining, processing, and storing of DNA profiles in the Forensic DNA Database of South Africa (NFDD) [16, 75, 76, 17]. In Egypt, there is no definitive legislative provision for the use of DNA evidence, obtaining, processing, and storing DNA profiling in the Egyptian National DNA Database (END) [75, 77]. However, it is reported that the Egyptian courts have frequently dealt with forensic DNA evidence [77]. for the rest of the enlisted African countries with reported DNA databases as demonstrated in figure 1, are yet to adopt specific and express legislative provision for their respective forensic DNA databases [75, 44, 28]. In Nigeria however, legislative provision for the establishment of a forensic DNA database is underway [75]. Prominently, The Senate Bills: SB: 78 Deoxyribonucleic Acid (DNA) Bill, 2015 sponsored by Senator Theodore A. Orji [78, 75].

Benefits of Forensic DNA Database and Forensic DNA evidence

The forensic DNA database has been in discussion ever since its introduction in the UK in 1995, and its benefit has also been a subject of extensive debate around the world. In light of this, an examination of existing literature revealed the benefits of a forensic DNA database as shown in fig. 2. As a prelude, Forensic DNA database is a computer database containing records of DNA profiles primarily for comparison to produce hits between stored DNA profile and either of suspects, victims, or crime scene sample [30, 37, 79]. The incredible power of DNA technology as an identification tool constitutes a significant investigative resource in contemporary criminal justice systems [79, 31].

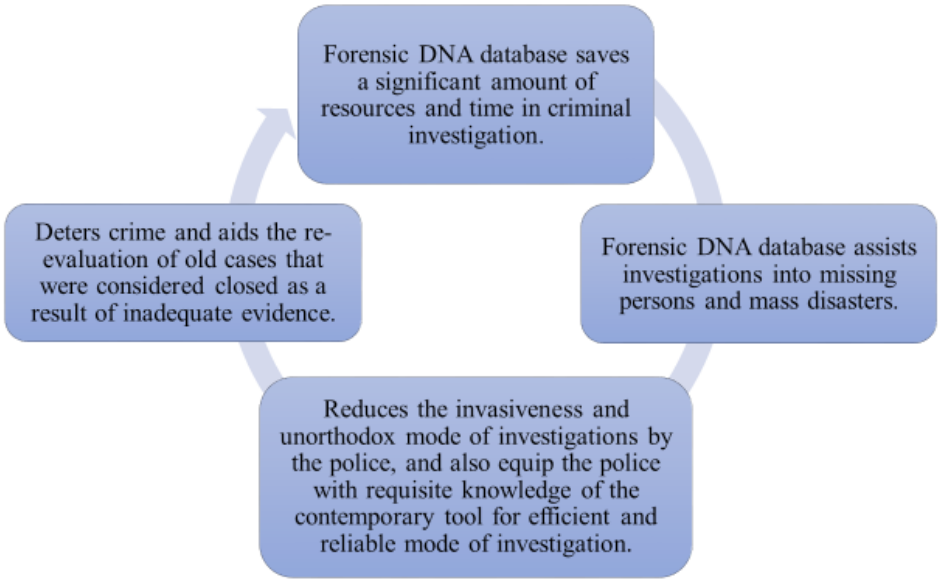

Figure 2: Benefits of Forensic DNA database based on the assessment of existing literature [80-82].

Conclusion

DNA database confers enormous benefits in efficiently and effectively solving crimes, and exonerating the innocent. As result, many countries around the world now operate forensic DNA-databases to identify owners of crime-related stains. Despite the demonstrated effectiveness of DNA database in the criminal justice system, the operation and use remain unpopular in Africa. Therefore, the present review provides information as to the position of Africa, particularly Nigeria in the use of forensic DNA database for crime investigation. Based on the findings from this review, it is recommended that the enactment of legislation or a review of the existing ones regarding the use of DNA as evidence, and the establishment of a DNA database be considered in Nigeria. The Nigeria government should collaborate with National University Commission to ensure that Nigeria Universities start running programs in forensic science, as this will greatly increase the awareness and provide the requisite knowledge for expertise in the field of forensic science.

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