International Journal of Life Sciences
International Peer Reviewed Open Access Journal

Special Issue A15, March 2021
ISSN:2320-7817(p) 2320-964X(0)

Review Article Open Access

Nanobiotechnological armour in forensic investigation- A review on upcoming perspectives in forensic biology

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Manuscript details:

Available online on http://www.ijlsci.in
ISSN: 2320-964X (Online)
ISSN: 2320-7817 (Print)

Cite this article as:
Shende VA, Paikrao HM, Thakare SR and Patil KG (2021) Nanobiotechnological armour in forensic investigation- A review on upcoming perspectives in forensic biology, *Int. J. of. Life Sciences*, Special Issue, A15: 1-8.

Article published in Special issue of International e-Conference on "Forensic Biology"(ICFB-2021) organized by Department of Forensic Biology & IQAC, Government Institute of Forensic Science, Nagpur, Maharashtra, India date, February 28th & 29th, January, 2021.

ABSTRACT

Nanobiotechnology is an emerging field of forensic science that investigates biosensors, biological indicators, food adulteration, real-time crime scenes and terrorist activities using nanomaterial. Extraction and quantification of excellent quality of DNA through PCR from body fluids and skeletal remains for forensic analysis using silica, magnetic nanoparticles and nanoparticle of coppers were used to solve criminal cases. Evaluation and identification of toxic substances from skeletal remains, blood, saliva and hairs will be done by using nanobiotechnology. Nanobiotechnology played a major role in the future to deliver more selective and sensitive ways to help forensic investigators to solve crime cases with more success.

Keywords- Nanobiotechnology, DNA analysis, PCR, Forensic Biology, Toxicology, Nanoparticles, Nanotechnology.

INTRODUCTION

Nanotechnology is a recent developing field and has been applied to different fields of science including biomedical sciences, materials sciences, physical sciences, building, hardware and numerous others. It is an ever-extending region of science that centers around the most diminutive parts or rather particles of structures whose size of roughly 1-100nm. Nanostructures are increasingly steady, far more grounded and have a bigger surface zone for every unit as contrasted and mass materials. Nanostructures start showing quantum impacts underneath 10nm.

Nanotechnology is a basic innovation permitting us to do new things in pretty much every possible mechanical control. It is one of the most

encouraging however questionable developing innovation among the existed advancements. The examination in measurable science saw as the way toward utilizing explicit strategies and techniques for investigating, assembling, and breaking down follow confirmations at the location of wrongdoing. These days, nanotechnologies in legal science will fundamentally change the procedures of examination by making them progressively delicate, increasingly exact, increasingly compelling, quicker and simpler to apply that clarifies the unquestionable importance of nanotechnologies (Lodha et.al., 2016). Nanoplatform alone or in intersection with different advancements were required to have noteworthy application in DNA examination, security, touchy location and medication screening which empower legal agents to perform complex investigation or to find even the littlest hints of proof at the crime scene (Chen, 2011).

Nanotechnology as another territory of research, includes the noteworthy of cases and confirmations under the watchful eye of the court of intrigue at whatever point it is compulsory and are being fused in the field of forensic science. Huge assortments of strains and excellent arrangement information will give the significant outcomes in microbial forensic examinations. Nano-analysis is most generally observed in forensic science with instrumentations including TEM, SEM, AFM and Raman micro-spectroscopy among the different nanotechnologies. Since nano-analysis identify and analyze tests in the nanoscale, basic proof that couldn't be gathered and broke down before because of the recognition furthest detection limits of the instruments are presently be analyzed and used to help the examinations. Nanomaterials have novel properties that can help the assortment and discovery of proof which can't be obtained beforehand. (Chen, 2011). Forensic science intends to recognize, individualize and assess proves by applying information and methods from regular science. Evidences were utilized to remake wrong doing scenes, direct examinations and carry hoodlums to equity.
In forensic science vows to reform the pertinence of smaller scale fluidic frameworks in post-polymerase chain response (PCR) measurement, DNA extraction media, unique mark representation by utilizing nano-powder. Forensic Nanobiotechnology will change the cumbersome instruments into little chip-based stages and abbreviate examination techniques to make examinations, delicate and opportune appropriate. Nanobiotechnology is utilized to recognize obscure human remains utilizing forensic genetics /DNA and can possibly give exact individual distinguishing proof in convenient, non-hazardous and with simple way from very small samples.

Nanoparticles-

It was uncovered that nanoparticles have size extents from scarcely any nanometer to 500 nm. While the morphology is likewise controllable. Because of their minuscule size, nanoparticles have huge surface zone, which make them appropriate possibility for different applications. Close to this, the optical properties are like-wise prevailing at that size, which further increment the significance of these materials in photocatalytic applications. Engineered methods can be valuable to control the particular morphology, size and attractive properties of nanoparticles. The quick progression in nanoparticles sets new standards in science and innovation,

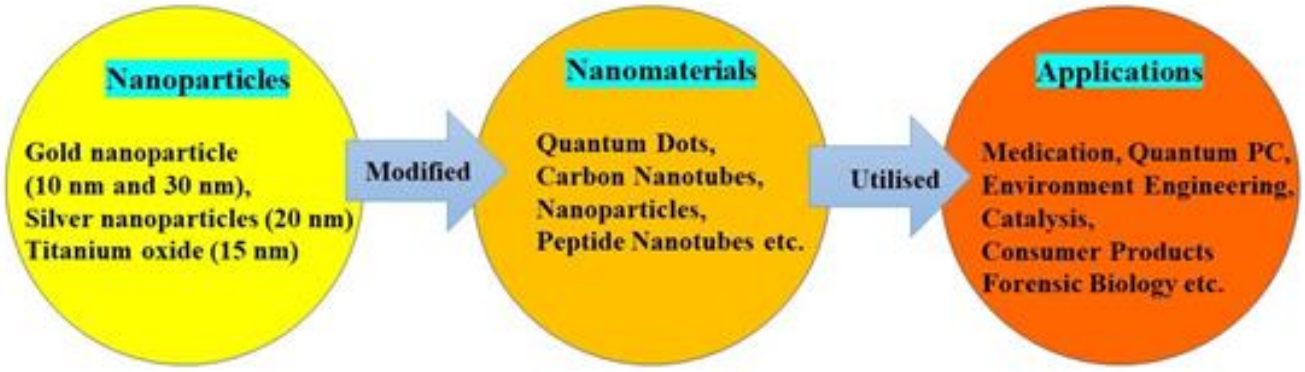

Figure-1: Nanoparticles are modified into nanomaterials and utilised in various field.

yet all the while expanded worries about the health dangers of nano-objects. As of late, different sorts of nanoparticles utilized in a few regions of forensic including paint, inks, security record and to build up the inactive unique mark (Khan, et al., 2019 and Chauhan, et al., 2017). Gold nanoparticle (10 nm and 30 nm), silver nanoparticles (20 nm) and titanium oxide nanoparticles (15 nm) have been utilized for recognizable proof and asserted that these nanoparticles improve the discovery furthest reaches of the drugs in fingerprint samples. These days, quantum dots (Semiconductor nanomaterials), carbon nanotubes, nanoparticles and peptide nanotubes were few of the instances of nanomaterials which were utilized in the field of medication, quantum PC, environment engineering, catalysis, consumer products and correspondence (Fig.-1) (Pandya and Shukla, 2018; de Morais, et al., 2014; Chakraborty et al., 2015 and Gohil et al., 2011).

Au nanoparticles can be utilized to drastically improve polymerase chain reaction (PCR) productivity. At the point when 0.7 nm of 13 nm Au nanoparticles were added into the PCR reagent, the response time was diminished while warming/cooling and warm cycle rates were expanded. It has been recommended that affectability improved 5∼10 times in traditional PCR and in excess of 10,000 times in real-time PCR (Prasad et al., 2020 and Li et al., 2005). The marked enhancements in PCR productivity were credited to the heavenly heat transfer property of Au nanoparticles, another research group have additionally started to use nanoparticles to forensic biology related researches (Turner and Turner, 2010 and Kumar et al., 2016). For the forensic investigation, high quality DNA samples which were amplified by PCR can be extricated from various skeletal remains and body liquids with the assistance of copper nanoparticles and magnetic nanoparticles including silica (Lodha et al., 2016).

Magnetic nanoparticles can form more stable complexes with saliva, blood and bacterial culture. Extraction of genomic DNA from saliva and blood where they accomplished synchronous improvement of target cells and adsorption of DNA on practically altered magnetic nanobeads (Xie et al, 2007). Magnetic nanoparticles have become an inexorably mainstream method for the division of biomolecules in particular proteins, DNA and RNA. To remove genomic DNA from body fluids (saliva, blood and semen) magnetic particles have been effectively used. Magnetic particles coated with polymers like silica, carboxyl, agarose have been used for isolation of DNA. Solid phase systems adsorbed DNA-silica-based particles, glass fibers, changed magnetic beads and anion-exchange carriers have been utilized as a preferred position of least DNA degradation during its purging (Saiyed and Ramchand, 2007 and Gong and Li, 2014).

Nanoparticles in forensic biology -

Nanotechnology permits clinical experts to survey, caution and secure people in general comparable to the bioterrorist dangers. Usage of a measurable convention of nanotechnology sensors quickly and adequately to distinguish biohazardous substances related with the proper equity framework. Nanotechnology diagnostics would all the more quickly identify pleural emissions, rib breaks, shrapnel, cracked organs and veins/arteries (Oxenham, 2008).

Nucleic acid nanotechnology has numerous different applications other than clinical finding and medication treatment. Engineered polymers, for example, dendriworms, made up of dendrimer units of magnetic nanoworms were being utilized for intercellular conveyance of little meddling RNA (siRNA). These siRNA transporters were gathered from magnetic just as fluorescent nanoparticles. The magnetism of nanoworms permitted to be coordinated to a specific area, while the fluorescence permits identification. siRNAs were known to be answerable for both initiation and hushing of mammalian genes (Zahid, 2013).

Other than the conveyance framework, the nanoparticles can go about as a functioning substance. Nanoparticles have discovered their way through the circulation system into a tumor or have been infused legitimately into it, metal-containing nanoparticles can be warmed utilizing near-infrared radiation or a quickly swaying magnetic field (Johannsen et al., 2005) so the tumour cells pass on.

Nanobiotechnology-

Nanobiotechnology is comprised of 'nano' relates to the investigation or improvement of structures in the 1 nm to 100 nm size range in any event one measurement; while 'biotechnology' alludes to mechanical apparatuses related with the advancement of living things or natural particles

(Fig.-2). In this manner, parts of regular organic frameworks were investigated by nanobiotechnologists by utilizing imaginative nanodevices. Nanobiotechnology gave another point of view on examination and treatment in medication and pharmacology which prompted the improvement of another field called nanomedicine. Numerous pharmaceutical organizations were extending their examination to the utilization of nanotechnology in imperative zones of medication, for example, sedate conveyance and illness treatment (Prasad et al., 2020 and Sekhon, 2005). In nanobiotechnology, devices from nanotechnology were created and applied to consider organic wonders. Nanoparticles are utilized for tests, sensors or vehicles for biomolecule movement in cell frameworks. Nanobiotechnology covers all parts of research and rising advances including major hypotheses and strategies at the smaller scope and nano-scale and ideas applied to biomedical-related gadgets (de Morais et al., 2014).

Nanobiotechnology is a developing field of forensic science that explores continuous crime scenes and terrorist activities, biosensors, biological indicators and food contaminated utilizing nanomaterial. Nanotechnology helps in diagnosing and checking samples at the nano-scale level that was before troublesome because of the identification furthest reaches of machines. Tests including DNA fingerprints, gunshot residues, explosives, substantial metals can be distinguished utilizing nanotechnology (Chen, 2011). Nanobiotechnology has applied in life sciences as standard biomedical applications in assorted areas like gene therapy, drug delivery and novel drug revelation methods (Chauhan et al., 2017; Pandya and Shukla, 2018 and de Morais et al., 2014).

DNA nanotechnology is one significant case of nanobiotechnology in which the nucleic acids like DNA is used to make valuable materials in a promising region of present-day research. Another significant zone of research includes exploiting membrane properties to produce synthetic membranes. Protein collapsing considers give a significant road of research, however one that has been to a great extent hindered by our failure to anticipate protein collapsing with an accuracy. Nanobiotechnology could demonstrate exceptionally productive later on natural frameworks for proteins research to understanding protein folding. Lipid nanotechnology is another significant zone of research in nanobiotechnology, where auto-assembly and antifouling is misused to manufacture nanodevices with applications in medication and building. With the assistance of nanotechnology discovery and investigation of a solitary DNA atom in legal research would be conceivable (Saiyed et al., 2008).

Toxicology

Nanobiotechnology is most successfully applied in the field of forensic toxicology in current situation for identification and measurement of various harmful substances from different forensically significant confirmations like, saliva, blood, vitreous humor, hair, unique mark tests and even from skeletal remains. Identification and assessment of toxic substances from various crucial forensic samples, for example, blood, hair, saliva, palm-print or unique fingerprint samples and skeletal remains should be possible using nanotechnology. By investigating the spectroscopic properties of nanoparticles, illicit drug like cocaine were measured in the fingerprint samples. Detection limit of these prohibited drugs were enhanced in the fingerprint samples by utilizing gold, silver just as titanium oxide nanoparticles (de Morais et al., 2014; Chakraborty et al., 2015 and Harvey, 2015). A nanosensor was created so as to distinguish clonazepam drug from the blood and skeletal examples by utilizing melamine altered gold nanoparticles (Lodha et al., 2013). So also, sensors had produced to improve things, fast and reasonable on-field test. Financially accessible bioanalyzer, Agilent 2100 can build the DNA tests even upto nanoliter scale inside an extremely limited capacity to focus time and in this manner, were utilized to measure mitochondrial DNA tests in forensic research (Ganesh 2016; Kaushik et al., 2017 and Hallikeri et al., 2014).

Nanochips

DNA chips utilized for analyzing DNA have been accessible for a couple of years at this point. These chips are at present and generally utilized in logical, biomedical research however they are once in a while utilized in clinical practice. The chips contain a dormant support which conveys microarrays of hundreds to thousands of single strand DNA molecules with various base groupings. DNA from a tissue sample that has been named with a radioactive or fluorescent material can be recognized based on the spot on the chip where it ties to the chip

DNA. Nanotechnologies are likewise progressively assuming a job in delivering the chips and in expanding their recognition affectability and unwavering quality (Vo-Dinh, 2001).

The programmable bio-nano-chip (p-BNC) incorporates an analyzer with practical integrated mechanical/optical interfaces and adaptable microchip engineering. An infusion shaped, "credit card"- measured cartridge encases either a dot cluster or a layer, where complex immunoassays or cell examinations are performed separately. The cartridge is made out of a system of microfluidic components that ensure the total exchange and handling of biological examples to give quantitative data of the targated biomarkers. The sample presentation necessities are reliable with the utilization of saliva, serum, plasma and little volumes of blood for the appraisal of cardiovascular hazard and health or tissue brush tests that can be legitimately regulated into the sample introduction port. Reagents are put away dry on a conjugate cushion inserted inside the biochip and are disintegrated varying through the arrival of prepacked buffer contained in biochip-incorporated pockets. All the handling advances are led inside the microfluidic system of the p-BNC by means of incitation inside the analyzer without human mediation. These highlights dispense with the requirement for outer fluidics, for example, siphons, tubing and connectors. The p-BNC assay methodology is anything but difficult to utilize, fast, ease, multiplexed, and completely quantitative used for detection of drugs in non- invasive oral fluid specimens (Christodoulides et al., 2017).

Labs-on-a-chip were pocket-sized labs and can be utilized for analyzing biopolymers research about and controlling cells. They were relied upon to assume a significant job in the further improvement of biosensors for the location of pathogenic microorganisms. Nanotechnologies offer various opportunities for improving existing and structuring new imaging methods. Superparamagnetic nanoparticles of iron oxide are currently being utilized clinically as MRI differentiate specialist. They accumulate after intravenous organization in liver, spleen and lymph organs, along these lines empowering investigations of those organs. Most nanosystems are planned from organic materials, for example, DNA and RNA are 'modified' to have the option to sidestep most, if not all, drug-resistance systems. In view of these properties, most nanosystems had the option to convey high concentrations of medications to cancer disease cells while shortening harm to encompassing healthy cells (de Morais et al., 2014 and Acharya et al., 2009).

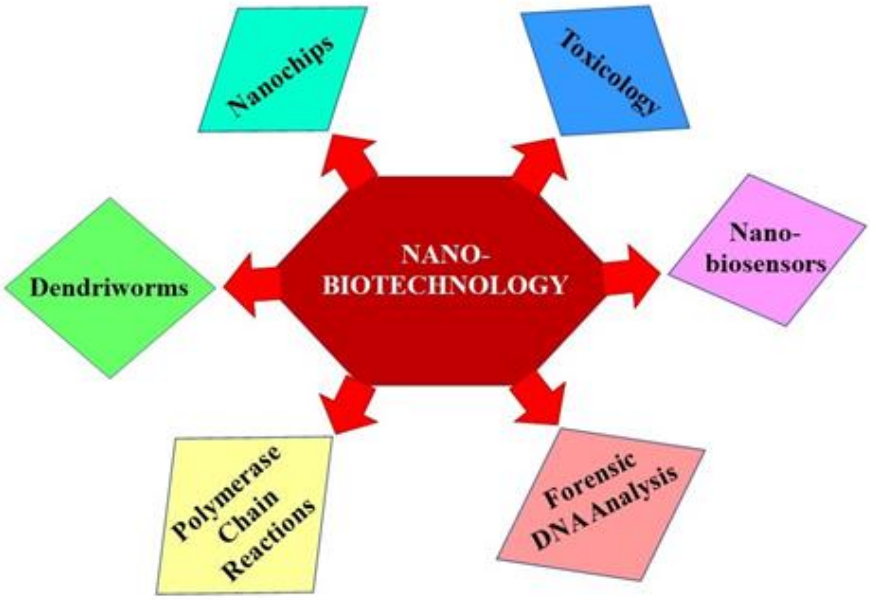

Figure-2: The potentiality uses of nanobiotechnology in many different forensic investigations like Forensic DNA Analysis, Nanochips, Dendriworms, Toxicology, Nanobiosensors for DNA fingerprinting, Polymerase Chain Reactions, etc.

Analysis of Forensic DNA

Forensic DNA examination is conveyed in murder cases, assault cases and other crime cases. These days, magnetic nanoparticles are being utilized to separate DNA from various natural biological sources like the blood, hair, skin, semen and spit (Castella, et al., 2011). Recently, advanced microfluidic gadgets are utilized for forensic DNA examination. The advantages of these gadgets are shorter assessment time, danger of tainting is less and straightforwardly material at the crime scene. Microfluidic chip innovation has just demonstrated to be helpful and effectively powerful in clinical applications, for example, for point-of-care use (Singh et al., 2015 and Nikalje, 2015).

DNA examination is generally acknowledged strategies for individual distinguishing proof. DNA extraction and separation from antiquated bone samples, degraded body parts and so on was very troublesome and testing task for forensic researcher. Be that as it may, new upcoming innovation like nanotechnology will help for investigation of such examples for DNA (Ansari et al., 2018). DNA analysis is the quickest innovative upheaval since Human Genome Project. DNA examination should be possible in number of ways viz short tandem repeat investigation (STR), Y-chromosome investigation, mitochondrial DNA examination. PCR is a substantial method utilized with STR for DNA investigation. The essential procedure of DNA investigation can be summarized in three sections i) DNA extraction from the sample, ii) Quantification and enhancement utilizing the PCRs and iii) Gel/capillary electrophoresis. The customary strategies to extricate DNA from urine, blood or semen includes centrifugation or filtration which are less work, escalated and tedious procedures. As a rule, a total DNA examination may take an entire day or two. The examination endeavors in nanobiotechnology area focus around upgrading precision just as making the procedure quick and faster (Pandya Shukla, 2018; Srividya, 2016; Aboud et al., 2013 and Kaushik et al., 2017).

Greater advancement happens in the field of DNA investigation by creating nanotechnology-based apparatuses that can be utilized to peruse DNA sequence in a molecule directly. In addition, by putting the DNA molecules on carbon nanotubes, DNA grouping can be analyzed utilizing atomic force microscopy technique (McCord, 2006).

Polymerase Chain Reactions

Nowadays, nanoparticles have incorporated in the process of polymerase chain reaction-amplification because of their unique ability to make chemical and physical properties dependent on what might be available on the surface (Aggarwal et al., 2011). In forensic DNA typing, better quality of PCR (polymerase chain reaction) extraction is exceptionally significant. DNA samples from body fluids and skeletal remains were used for forensic investigation. To extract better quality of PCR products, silica based Magnetic nanoparticles, magnetic nanoparticles and copper nanoparticles were utilized. The magnetite nanoparticles with carboxylic compounds were utilized as adsorbents to isolate DNA in PCR. (Srividya, 2016; Singh, 2014 and Satvekar et al., 2014).

The most across the board scientific use of microfluidic frameworks is post polymerase chain reaction (PCR) quantization. These frameworks are right now being utilized in many forensic research laboratories to perform post-PCR quantification of mitochondrial DNA. The evaluation of post-PCR (polymerase chain reaction) is the most extreme broad scientific forensic nanotechnology utilization of the microfluidic systems. In an exceptionally brief timeframe i.e., inside 30 minutes DNA tests can be measured even in nanoliter go utilizing industrially accessible Agilent 2100 bioanalyzer. These frameworks are by and by being utilized to measure mitochondrial DNA in numerous forensic science research centers. Because of their little size, the imminent of such gadgets being utilized at the location of crime is widely determined. These little gadgets are performed fast, expendable that requires negligible clean-up and maintenance that will edge the innovation (Prasad et al., 2020 and McCord, 2006).

It is likewise significant to extract the great quality PCR prepared DNA tests for forensic DNA typing. Numerous writers utilized magnetic nanoparticles, silica based magnetic nanoparticles and copper nanoparticles for extraction of good quality PCR prepared DNA tests from various forensically noteworthy body liquids and skeletal remains samples. Nanoparticles have significant consideration in science and medication due to their promising applications. Hot start like impact in gold nanoparticle-based PCR has been held, which promising applications in nanobiological and biomedical examinations (Dun et al.,

2011). DNA extricated from urine utilizing organic reagents while carboxylated magnetic nanoparticles are utilized as solid phase adsorbents to isolate unblemished DNA for PCR amplification (Shan et al., 2012).

Recent advances

Nanobiosensors have been investigated for their clinical applications as an extra device in analysis of a specific disease or an infectious micro-organism. Similarly, numerous materials and membrane gatherings with the guide of nanotechnology had continually been created to help in recognizing the DNA fingerprints, particularly in crime occurrences. Ongoing advances incorporate utilization of capillary electrophoresis, nano-gold, nano-silver and nano particles of titanium dioxide (TiO2) combined with SEM, TEM and FTIR (Chen et al., 2015).

Advancements in nanotechnology apparatuses like nanoprobes, nanodevices and nanochips can be successful ways to deal with forestall crime and give expanding security to the people. Nanotechnology can be useful to shield individuals from fluctuated scope of crimes like rough violations, assault, murder, robbery, misrepresent-tation and terrorist assaults. Nanoplatform will assist with improving the evidence analysis technique (identification, assortment and protection of evidence) acquired from the crime scene and give pace in examination process.

CONCLUSION

Article illustrates the potentiality uses of nanobiotechnology in many different forensic investigations like Forensic DNA Analysis, Nanochips, Toxicology, Nanosensors for DNA fingerprinting, Polymerase Chain Reactions, etc. Development of multifunctional nanodevice as handheld mini-lab at the crime scene will help to analyze the evidence on the field that would save the time, collection, examination in different stages of criminal investigation. New nanomaterials with more sensitive and advanced techniques are quite challenging and need of the hour for performing DNA analysis. Due to constant development of nanotechnology, forensic scientists will be encountering various evidences in the nanoscale in the future. Finally, to further develop novel forensics and related studies, long-term exchange opportunities with international forensic scientists must be sought to ensure our awareness of the latest development in forensic science and nanobiotechnology with skilled workforce, education researches, supporting infrastructure and tools to advance nano-technology. Future work will be set on the portrayal of an assortment of novel nanoparticles particularly the artificially altered nanoparticles in breaking down legal medications including cocaine, methamphetamines and cannabis utilizing bioanalytical procedures. It concludes that the nanobiotechnology is fast, accurate, more reliable secure system and armour in forensic investigation which will be a future of forensic sciences.

Conflicts of interest: The authors stated that no conflicts of interest.

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