

**SYNTHESIS OF SILICA NANOPARTICLES FROM DATE PALM SEEDS FOR  
LATENT FINGERPRINT DEVELOPMENT**

**BY**

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## CERTIFICATION

This is to certify that this work was carried out by **ODUVWU EJIROGHENE DEZIRI** with Matriculation Number **PSC1808553** of the Department of Chemistry, University of Benin.

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## **DEDICATION**

This project work is dedicated to God Almighty for the gift of life, wisdom, knowledge, understanding and sustainability.

To my loving and caring Family and those who contributed in one way or the other to the successful accomplishment of my B.Sc. program.

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## **ABSTRACT**

This research introduces a pioneering method to improve latent fingerprint visualisation by synthesising silica nanoparticles from date palm seeds. Fingerprint identification is crucial in forensic science, but the quality of latent fingerprints greatly affects its reliability. Silica nanoparticles, with unique properties, are ideal for this purpose, and date palm seeds naturally contain them. This study focuses on extracting, purifying and confirming successful amorphous silica nanoparticle production. Preliminary findings indicate that these nanoparticles enhance latent fingerprint visibility on various surfaces, offering an eco-friendly approach to forensic science. This research promises to advance fingerprint identification by merging nanotechnology and forensic science through date palm seed-derived silica nanoparticle.

# CHAPTER ONE

## 1.0 INTRODUCTION AND LITERATURE REVIEW

### 1.1 INTRODUCTION

Fingerprint identification is a fundamental and widely utilized biometric technique in forensic science and security applications. Its reliability and uniqueness have made it an invaluable tool for personal identification and criminal investigation.

Forensic science is a multidisciplinary field that involves the application of scientific principles and techniques to investigate and solve crimes. Its primary goal is to provide objective and unbiased evidence to aid in criminal investigations and legal proceedings. Forensic scientists analyse physical evidence collected from crime scenes, victims, and suspects to help establish facts, identify suspects, and support or refute claims made in a court of law.

Key areas within forensic science include: DNA Analysis, Forensic Pathology, Forensic Toxicology, Fingerprint Analysis, Forensic Anthropology, Ballistics and Firearms Analysis and Digital Forensics.

Forensic science plays a vital role in the criminal justice system, helping to establish guilt or innocence, locate missing persons, and provide closure to victims and their families. It requires a combination of scientific knowledge, attention to detail, and adherence to strict protocols to ensure the integrity of evidence and the accuracy of findings. Silica nanoparticles, with their small size and high surface area, possess unique optical, chemical, and physical properties that can significantly improve the visualization and preservation of latent fingerprints.

Traditional methods of fingerprint enhancement often involve powders and chemical reagents that may be hazardous and less effective. However, the use of silica nanoparticles derived from date palm seeds offers a promising alternative that is not only environmentally friendly but also highly efficient in latent fingerprint development.

Date palm fruits are the fruit of the date palm tree, they are grown in the Canary Islands, northern Africa, the Middle East, Pakistan, India, Mexico, and the U.S. state of California. Dates are chewy with a sweet flavor. They are also high in some important nutrients and have a variety of advantages and uses when consumed. The seeds are discarded after consumption as agricultural waste. This agricultural waste has been confirmed to be useful in forensic science.

Date palm seeds, a natural source of silica, contain amorphous and well-structured silica nanoparticles within their composition. Extracting and synthesizing silica nanoparticles from date palm seeds present an opportunity to create a sustainable and cost-effective material for fingerprint enhancement. This research aims to explore the synthesis of silica nanoparticles from date palm seeds and effectiveness in fingerprint identification.

The synthesis of silica nanoparticles from date palm seeds involves a series of chemical and physical processes, including extraction, purification, and characterization. Once obtained, these nanoparticles can be applied to latent fingerprints, enhancing the visibility of ridge patterns and increasing the accuracy of fingerprint identification. Moreover, the eco-friendliness of this approach aligns with current efforts to develop sustainable forensic techniques.

This research project seeks to bridge the fields of nanotechnology and forensic science, offering a novel and environmentally conscious solution for improving the efficiency and reliability of fingerprint identification. By harnessing the unique properties of silica nanoparticles derived from date palm seeds, this study aims to contribute to the advancement of forensic techniques and ultimately aid law enforcement agencies in solving crimes and ensuring public safety.

### **1.1.1 BACKGROUND OF STUDY**

Fingerprints have been one of the most important gold biometric features for personal identification in the forensic science field for more than 100 years, because of the uniqueness and lasting consistency over the lifetime.

The accuracy and reliability of this technique depend on the quality of fingerprint residues left at crime scenes, which can be compromised by various environmental factors, such as moisture, contaminants, and surface characteristics. To enhance

the sensitivity and effectiveness of fingerprint analysis, the development of novel materials and methods for lifting and preserving these prints is essential.

Nowadays, many methods exist as standard methods for the development of the latent fingerprints on common substrates in routine forensic practice (Ezhilmaran and Adhiyaman, 2017; Lennard, 2020), but there are still some situations that it is difficult or impossible to recover latent fingerprints for forensic investigators. (Nakamura *et al.*, 2015; Zhao *et al.*, 2016; Figueroa *et al.*, 2017; O'Neill *et al.*, 2018; Kolhatkar *et al.*, 2019; Bodelón and Pastoriza-Santos, 2020; Li *et al.*, 2020).

The most commonly used procedures for developing latent fingerprints are powder-dusting and spraying methods in both forensic practice and research field, and the developed images are stored as evidences, so colored dusting powders have attracted much attention from related research community (Cadd *et al.*, 2015; Friesen, 2015; Huynh and Halánek, 2016; Jie *et al.*, 2020).

Silica nanoparticles have gained considerable attention in recent years for their exceptional properties, including their high surface area, tunable surface chemistry, and low toxicity. These properties make them promising candidates for improving the quality and longevity of lifted fingerprints. However, the synthesis of silica

nanoparticles from conventional sources often involves energy-intensive processes and chemical precursors that are not environmentally friendly.

Date palm seeds, a readily available agricultural waste product in many regions, offer a sustainable and cost-effective alternative source of silica nanoparticles. These seeds contain abundant natural silica, which can be extracted and converted into nanoparticles through an eco-friendly process. By harnessing the unique properties of silica nanoparticles from date palm seeds, it is possible to develop a novel and sustainable approach to fingerprint enhancement and preservation.

This research seeks to explore the synthesis of silica nanoparticles from date palm seeds and evaluate their potential for fingerprint identification applications. By addressing the challenges associated with traditional fingerprint analysis methods, this study aims to contribute to the advancement of forensic science, ultimately improving the accuracy and reliability of fingerprint identification in criminal investigations.

### **1.1.2 STATEMENT OF PROBLEM**

Some of the chemical substrates used in fingerprints powder are toxic and pose potential health hazards. In order to overcome this disadvantage, we have attempted to use new powders for developing latent fingerprints which are simple, non-toxic, less expensive than the commercially used fingerprint powders (R. Rohatgi *et al.*, 2014). The reliable and cost-effective synthesis of silica nanoparticles from date palm seeds presents a significant challenge in the field of forensic science for fingerprint identification. This study aims to address the problem of limited availability of efficient and eco-friendly methods to produce high-quality silica nanoparticles from this sustainable source, hindering advancements in fingerprint analysis and forensic investigations.

### **1.1.3 RELEVANCE OF STUDY**

In this present study, a preliminary attempt made to synthesise silica nanoparticles from date palm seeds for fingerprint identification holds significant relevance in the following ways:

- 1. Forensic Advancements:** Enhancing the quality and longevity of lifted fingerprints is crucial in forensic investigations. The development of a sustainable

and efficient method for producing silica nanoparticles from date palm seeds can contribute to the advancement of fingerprint analysis techniques, aiding law enforcement agencies in solving crimes more effectively.

**2. Sustainability:** Utilizing date palm seeds as a source for silica nanoparticles aligns with sustainability goals. It repurposes agricultural waste, reducing environmental impact and promoting the use of renewable resources in materials science.

**3. Cost-Effectiveness:** Date palm seeds are abundant in many regions, making them a cost-effective source for silica nanoparticles. This research can lead to the development of affordable and accessible materials for law enforcement agencies, especially in resource-constrained areas.

**4. Green Chemistry:** The eco-friendly synthesis process of silica nanoparticles from date palm seeds contributes to the principles of green chemistry, reducing the use of hazardous chemicals and energy-intensive procedures associated with conventional nanoparticle synthesis.

**5. Improving Fingerprint Preservation:** The study's outcomes could lead to improved methods for preserving and enhancing latent fingerprints on various

surfaces, overcoming challenges posed by environmental factors and surface conditions.

**6. Interdisciplinary Impact:** This research bridges materials science, agriculture, and forensic science, demonstrating the interdisciplinary nature of scientific progress and encouraging collaboration among different fields of study.

In summary, the study's relevance lies in its potential to advance forensic science, promote sustainability, reduce costs, and contribute to the development of eco-friendly materials with applications beyond fingerprint identification.

#### **1.1.4 SCOPE OF STUDY**

The scope of this study encompasses several key aspects:

1. **Synthesis Methodology:** To develop a novel method for synthesising silica nanoparticles from date palm seeds, considering the specific characteristics of these seeds as a precursor.
2. **Fingerprint Identification:** Explore the potential of these silica nanoparticles in enhancing fingerprint identification techniques, such as dusting or latent fingerprint development.

3. **Feasibility and Applicability:** Assess the practicality and feasibility of using date palm seed-derived silica nanoparticles in real-world forensic applications.

### **1.1.5 AIM AND OBJECTIVES OF THE STUDY**

The aim of this research is to contribute to the field of forensic science by developing a sustainable and effective method for synthesising silica nanoparticles from date palm seeds and evaluating their suitability for improving fingerprint identification processes. The set objectives to achieve this aim were to:

1. To assess the potential of these silica nanoparticles in enhancing the visualization and preservation of latent fingerprints on various surfaces.
2. To compare the performance of date palm seed-derived silica nanoparticles with existing fingerprint development method.
3. To investigate the environmental sustainability of using date palm seeds as a precursor for silica nanoparticles in forensic applications.
4. To provide recommendations for the practical implementation of this technology in forensic laboratories and law enforcement agencies.

## **1.2. LITERATURE REVIEW**

## 1.2.1 LATENT FINGERPRINTS VISUALISATION



**Fig 1: Fingerprints.**

**Fingerprint Identification in Forensic Science:** Fingerprint identification has been a cornerstone of forensic science for over a century. The uniqueness and permanence of fingerprints make them invaluable for personal identification and criminal investigations. However, the effectiveness of fingerprint identification relies heavily on the quality and clarity of the latent prints recovered from crime scenes. Criminals have come to be careful to not leave any evidence at crime scene yet latent fingerprints are found in several crime scenes. Latent; meaning present but not yet active, developed, or obvious (*Cambridge dictionary*). Fingerprint is an impression or mark made on a surface by a person's fingertip, able to be used for identifying individuals from the unique pattern of whorls and lines on the fingertips.

Latent fingerprints are fingerprints that are present at crime scenes but not obvious. Although new methods have been developed to detect latent fingerprints, the traditional method for detecting latent fingerprints is the powdering method, which consists of a colourant for contrast and a resinous material for good adhesion. When powder is sprinkled over an affected area, it adheres to oil, sweat or other material left in the print while colorant in the powder gives contrast to the print from its background thus, helping in visualising the print.

**Challenges in Latent Fingerprint Development:** Developing latent fingerprints, particularly on porous or challenging surfaces, has been a long-standing challenge in forensic science. Traditional methods involve the use of powders, chemical reagents, or specialized light sources. These methods can be time-consuming, may damage fragile prints, and often result in incomplete or unclear ridge patterns.

Researches have been done on visualising latent fingerprints on various surfaces using powder form of turmeric; synthetic food and festival colours and silica gel. In their study it was concluded that turmeric powder and Silica gel are good substitutes to other conventional powders like black magnetic powder, grey powder etc. Although the results found by turmeric and synthetic food and festival colours were best for contrast surfaces.

Another study shows that fingerprints could be successfully enhanced and recovered from food surfaces such as banana, apple and potato when using black powder although Iodine fuming was also successful on apples (Singh G *et al.*, 2006). A further study focused on similar fruits and vegetables with some successful results. The process of cyanoacrylate fuming was also investigated in their study however, results proved less successful (Trapezar M. *et al.*, 2008).

A similar study conducted, focused on latent fingerprints enhancement and recovery on different fruits, vegetable and dairy product (egg). Black magnetic powder proved most successful on all surfaces. They also observed that using small particle reagent developed more than twice the amount of fingerprint albeit at a lower rating (Ferguson S. *et al.*, 2013).

Another experiment was conducted with small particle reagent based on crystal violet dye for developing latent fingerprints on wet non-porous surfaces and similar positive results were found on ceramic tile, glass and aluminium surface when immersed in clean water (R. Rohatgi *et al.*, 2014).

Latent fingerprints are invisible to the naked eye at crime scene. It could be exploited as a potential key evidence in countless cases of serious crime, requiring a special development process in order to visualise them by the police or other authorities. To identify individuals with fingerprints, there are three levels of fingerprint recognition.

The first-level features are macro details mainly used for the pattern classification, not distinctive enough to recognise fingerprint. The second-level features (minutia points) are distinctive and stable, widely used for distinguishing the uniqueness of fingerprint, while the third-level features (pores and ridge contours) are the dimension attributes of the ridges to provide more accurate and robust details for accurate fingerprint recognition.

As visualisation technology requires high quality and speed to identify individuals in forensic sciences, the visible detection of the latent fingerprints on different surfaces have been explored through a variety of spectroscopy methods, also called latent fingerprints imaging, visualisation, detection, or developing methods.

The most commonly used procedures for developing latent fingerprints are powder-dusting and spraying methods in both forensic practice and research field, and the developed images are stored as evidences, so colored dusting powders

have attracted much attention from related research community (Cadd *et al.*, 2015; Friesen, 2015; Huynh and Halánek, 2016).

The powder dusting method relies on the adherence of powder particles to the fingerprint deposits, forming patterns of ridges, and furrows for fingerprint identification. The fingerprint powders are categorized into metal powders, magnetic powders, and colored or fluorescent powders. Among them, colored or fluorescent powders are usually applied after cyanoacrylate fuming, and most of fluorescent powders are widely used on different surfaces under light irradiation for the high contrast with the surface background.

Nanoparticles are extremely small particles with dimensions typically ranging from 1 to 100 nanometers (nm). They can be composed of various materials, including metals, ceramics, polymers, or biological substances. Due to their small size, nanoparticles often exhibit unique properties and behaviors compared to their bulk counterparts.

Nanoparticles have diverse applications in fields such as medicine, electronics, materials science, and environmental science. They can be used in drug delivery, as catalysts, in electronics components, and for improving the properties of materials like strength or conductivity. Their small size allows them to interact with molecules and cells in distinctive ways, making them valuable in various scientific and industrial contexts.

**Nanoparticles in Forensic Science:** The integration of nanotechnology into forensic science has shown promising results in recent years. Nanoparticles, due to their unique properties, offer new avenues for enhancing latent fingerprint development. Nanoparticles can adhere selectively to the fingerprint residue, providing a higher contrast and more durable enhancement compared to conventional methods.

**Silica Nanoparticles for Fingerprint Enhancement:** Silica nanoparticles, with their small size and high surface area, have gained attention for their potential in fingerprint identification. They can bind to the fatty acids and amino acids in fingerprint residue, making the ridge patterns more visible. Additionally, silica nanoparticles are chemically stable and compatible with various surfaces, which is crucial for forensic applications.

**Date Palm Seed-Derived Silica Nanoparticles:** Date palm seed nanoparticles are biocompatible, sustainable, and cost-effective to produce. Several studies have explored the extraction and synthesis of silica nanoparticles from date palm seeds for various applications, however, their potential in forensic science, particularly in fingerprint identification, remains relatively unexplored.

**Environmental and Economic Considerations:** In recent years, there has been a growing emphasis on sustainable and eco-friendly forensic techniques. The synthesis of silica nanoparticles from date palm seeds aligns with this trend by utilizing a natural and renewable resource. Additionally, the cost-effectiveness of this approach could make it accessible to forensic laboratories with limited budgets.

**Future Prospects and Research Gaps:** While the synthesis of silica nanoparticles from date palm seeds holds promise for fingerprint identification, there is a need for comprehensive research to assess their efficiency, reliability, and compatibility with various surfaces and environmental conditions.

In conclusion, the integration of silica nanoparticles derived from date palm seeds into fingerprint identification represents an innovative and eco-friendly approach with the potential to address existing challenges in forensic science. This literature review highlights the significance of this research topic and the gaps that warrant further investigation to advance the field of fingerprint identification.

## **CHAPTER TWO**

### **2.0 MATERIALS AND METHODS**

#### **2.1. MATERIALS**

Materials used include; apparatuses and reagents

##### **2.1.1 APPARATUS**

- Round Bottom Flasks
- Volumetric Flasks
- Funnel
- Condenser
- Hot Plate
- Thermometer
- Beakers
- Measuring cylinders
- Retort Stand
- Clamp
- Dropper
- PH Metre

- Spatula
- Sieve
- Mortar and pestle
- Magnetic stirrer
- Aluminium foil paper
- Crucibles
- Filter papers
- Vacuum pump
- Buckner flask and funnel

### **2.1.2 REAGENTS**

- Sodium Hydroxide
- Hydrochloric Acid
- Tetraoxosulphate (vi) Acid
- Deionised Water

## **2.2. METHODS**

### **2.2.1 COLLECTION OF DATE PALM SEEDS (DPSs)**

Date palm fruits with a weight of 14.2kg was bought from Lagos Street Market located at Oredo LGA in Benin City. ii. The seeds were separated from the mesocarps and epicarps. The weight of the seeds collected was 3.3kg.



**Fig 2: Date Palm Fruits.**



**Fig 3: Date Palm Seeds**

### **2.2.2 PREPARATION OF DATE PALM SEED CHARCOAL**

**(DPSC)**



**Fig 4: Date Palm Seed Charcoal**

- I. The date palm seeds collected were washed thoroughly with running tap water to remove any adhering impurities.
- II. The washed Date Palm seeds were air-dried at room temperature to drain the water and oven dried at 378 K (105°C) for 45 minutes.
- III. The oven dried Date Palm seeds were crushed with a mortar and pestle.
- IV. The crushed Date Palm seeds were carbonised in a muffle furnace at 673K (400°C) for 3 hours to produce Date Palm seeds charcoal (DPSC).
- V. The Date Palm Seed Charcoal was crushed again with a mortar and pestle.



**Fig 5: Crushed Date Palm Seed Charcoal**

### **2.2.3 PREPARATION OF DATE PALM SEED ASH (DPSA)**

- I. The crushed Date Palm Seed Charcoal was further calcined in a muffle furnace at 1073 K (800°C) for 3 hours to produce Date Palm Seed Ash (DPSA).
- II. The Date Palm Seed Ash was homogenised in mortar and pestle.
- III. The homogenised Date Palm Seed Ash was sieved with 525mm sieve.

IV. The sieved Date Palm Seed Ash was put in an air-tight container for preservation.



**Fig 6: Date Palm Seed Ash**

#### **2.2.4 SYNTHESIS OF NANO SILICA**

- i. 10g of Date Palm Seed Ash was washed severally with deionized water to neutralise the pH and to remove the sand, dust and fine dirt. (The repeated washing of the Date Palm Seed Ash was to remove the adhered impurities on the surface of silica and neutralise the pH).
- ii. 6 N HCl was used to reflux the neutralised Date Palm Seed Ash for 90 minutes, with constant stirring using magnetic stirrer.
- iii. The stirred solution was filtered in order to remove metallic impurities and to extract pure nano silica.

- iv. The Date Palm Seed Ash after filtering was rinsed with hot deionized water repeatedly.
- v. The acid refluxed Date Palm Seed Ash was then boiled with 3 N NaOH solution at 353 K (80°C) for 90 minutes, under constant stirring magnetically.
- vi. The stirred NaOH solution was then filtered to obtain sodium silicates.
- vii. The residue was thoroughly washed with hot deionize water to extract sodium silicate completely.
- viii. The pH of the obtained filtrate (sodium silicate) was reduced to 2.0 by controlled addition of concentrated H<sub>2</sub>SO<sub>4</sub> and being stirred magnetically, to precipitate nano silica.
- ix. The precipitate obtained was washed thrice in warm deionized water and then filtered.
- x. The obtained residues were calcined at 873 K (600°C) for 3 hours in a muffle furnace to obtain silica.
- xi. The obtained silica was pulverized to nano silica powder using a mortar and pestle.



**Fig 7: Filtration of solution using vacuum pump**



**Fig 8: Magnetic stirring of date palm seed ash with HCl**



**Fig 9: Silica nanoparticles**

### **2.2.5 SYNTHESIS OF LATENT FINGERPRINT POWDER FROM SILICA NANOPARTICLES**

The fingerprint powder was formulated in a 4:3:3 ratio of silica powder, dye (methylene blue) and cornstarch respectively.

- i. 0.4g of silica nanoparticles, 0.3g of methylene blue ( $C_{16}H_{18}ClN_3S$ ) and 0.3g of corn starch were measured and mixed into a 100ml beaker to get 1g of mixture.
- ii. 2ml of ethanol was added to the 1g of mixture in the beaker to ensure homogeneity.

- iii. The solution was stirred consistently at 100°C on a magnetic stirrer until it formed an almost dried paste.
- iv. The paste was transferred into a crucible and placed in a hot air oven at 150°C until it reached a very hard and dry state with no visible state of moisture.
- v. The resulting dried clump of powder was crushed with a mortar and pestle into fine particles.
- vi. The fine particles were sieved using a 400-mesh screen to obtain finer particles.
- vii. The fine particles were stored in an airtight container until use.



**Fig 10: Latent fingerprint powder with methylene blue as dye**



**Fig 11: Commercial latent fingerprint powder**

## CHAPTER THREE

### 3.0 RESULTS AND DISCUSSIONS

#### 3.1 RESULTS



**a.**

**b.**

**Fig 12: Images of latent fingerprint pattern on glass slides with powder from date palm seed latent fingerprint powder (a) and commercial latent fingerprint powder (b).**



**a.**

**b.**

**Fig 13: Images of latent fingerprint pattern on aluminium foil paper with powder from date palm seed latent fingerprint powder (a) and commercial latent fingerprint powder (b).**



**a.**

**b.**

**Fig 14: Images of latent fingerprint pattern on stainless surface with powder from date palm seed latent fingerprint powder (a) and commercial latent fingerprint powder (b).**

### **3.2 DISCUSSIONS**

It is observed in fig 12(a), that there are more ridges formed by the date palm seed latent fingerprint powder compared to the commercial powder (b) used on the glass surface and this is as a result of some of the bi-chromatic properties of the commercial powder.

In fig 13, the prints of methylene blue powder(a) were more visible on aluminium foil paper and the prints from commercial powder(b) could slightly be seen because the background (aluminium foil paper) is similar to the commercial powder in terms of appearance.

On the stainless steel surface in fig 14, the print formed by methylene blue powder (a) is very clear and noticeable while that of the commercial powder is not as clear. This is because of the effect of methylene blue used as dye in the preparation of the date palm seed latent fingerprint powder.

Methylene blue has a deep blue colour and acts as a contrast which made the prints visible.

### **3.3 CONCLUSION**

The fingerprint powder derived from date palm seed has adherence properties on latent fingerprints. The fingerprint powder adhered well to the friction ridges and was easily brushed from the furrows.

Methylene blue acting as a contrast intensified the sharpness and darkness of the fingerprint's appearance.

Date palm seed fingerprint powder using methylene blue as dye/contrast is an effective method of developing fingerprint and as such could be used in forensic imaging.

## REFERENCES

- Bodelón, G., and Pastoriza-Santos, I. (2020). Recent progress in surface-enhanced raman scattering for the detection of chemical contaminants in water. *Front. Chem.* 8:478. doi: 10.3389/fchem.2020.00478
- Cadd, S., Islam, M., Manson, P., and Bleay, S. (2015). Fingerprint composition and aging: a literature review. *Sci. Justice* 55, 219–238. doi: 10.1016/j.scijus.2015.02.004
- CambridgeDictionary. <https://www.google.com/search?q=latent&ie=UTF-8&oe=UTF-8&hl=enng&client=safari#view=/dictionary>
- Ezhilmaran, D., and Adhiyaman, M. (2017). A review study on latent fingerprint recognition techniques. *J. Inf. Optim. Sci.* 38, 501–516 .doi: 10.1080/02522667.2016.1224468
- Ferguson S., Nicholson L., Farrugia K. J., Bremner D. H. and Gentles D., A preliminary investigation into the acquisition of fingerprints on food. *Science and Justice.* 53(1): pp.67-72 (2013). ISSN 1355-0306
- Figuroa, B., Chen, Y., Berry, K., Francis, A., and Fu, D. (2017). Label-free chemical imaging of latent fingerprints with stimulated raman scattering microscopy. *Anal. Chem.* 89, 4468–4473. doi:10.1021/acs.analchem.6b04213

- Friesen, J. B. (2015). Activities designed for fingerprint dusting and the chemical revelation of latent fingerprints. *J. Chem. Educ.* 92, 505–508. doi: 10.1021/ed500406v
- Huynh, C., and Halámek, J. (2016). Trends in fingerprint analysis. *TrAC Trends Anal. Chem.* 82, 328–336. doi: 10.1016/j.trac.2016.06.003
- Jie Lian, Fanda Meng, Wei Wang and Zhitao Zhang (2020). Recent trends in fluorescent organic materials for latent fingerprints imaging. Volume 8 - 2020 | <https://doi.org/10.3389/fchem.2020.594864>
- Kolhatkar, G., Parisien, C., Ruediger, A., and Muehlethaler, C. (2019). Latent fingermark imaging by single-metal deposition of gold nanoparticles and surface enhanced raman spectroscopy. *Front. Chem.* 7:440. doi: 10.3389/fchem.2019.00440
- Lennard, C. (2020). Fingermark detection and identification: current research efforts. *Aust. J. Forensic Sci.* 52, 125–145. doi: 10.1080/00450618.2018.1474948
- Li, J., Jiao, Z., Zhang, P., Wan, X., Song, C., Guo, Z., et al. (2020). Development of AIEgen–montmorillonite nanocomposite powders for computer-assisted visualization of latent fingermarks. *Mater. Chem. Front.* 4, 2131–2136. doi: 10.1039/D0QM00059K

Nakamura, A., Okuda, H., Nagaoka, T., Akiba, N., Kurosawa, K., Kuroki, K., et al. (2015). Portable hyperspectral imager with continuous wave green laser for identification and detection of untreated latent fingerprints on walls. *Forensic Sci. Int.* 254, 100–105. doi: 10.1016/j.forsciint.2015.06.031

O'Neill, K. C., Hinners, P., and Lee, Y. J. (2018). Chemical Imaging of Cyanoacrylate-Fumed Fingerprints by Matrix-assisted Laser Desorption/Ionization Mass Spectrometry Imaging. *J. Forensic Sci.* 63, 1854–1857. doi: 10.1111/1556-4029.13773

Richa Rohatgi and A. K. Kapoor (2014). New Visualizing Agents for Developing Latent Fingerprints on Various Porous and Non-Porous

Singh G., Sodhi G.S., and Jasuja O.P., Detection of latent fingerprints on fruits and vegetables. *Journal of Forensic Identification*, 56(3) 374-381 (2006).

Surfaces Using Different Household Food Items. *Asian Journal of Science and Applied Technology*. ISSN: 2249-0698 Vol. 3 No. 2, 2014, pp.33-38 © The Research Publication, [www.trp.org.in](http://www.trp.org.in)

Trapezar M. and Vinkovic M.K., Techniques for fingerprint recovery on vegetable and fruit surfaces used in Slovenia- a preliminary study. *Science and Justice* 48(4) 192-195 (2008).

Zhao, J., Zhang, K., Li, Y., Ji, J., and Liu, B. (2016). High-resolution and universal visualization of latent fingerprints based on aptamer-functionalized core–shell nanoparticles with embedded sers reporters. *ACS Appl. Mater. Interfaces* 8, 14389–14395. doi: 10.1021/acsami.6b03352

## **APPENDIX**

## PREPARATION OF 100ML OF 6N HYDROCHLORIC ACID FROM 37%

### HYDROCHLORICACID:

$$\text{Normality} = 2 \times \text{Molarity}$$

$$6 = 2 \times \text{Molarity}$$

$$\text{Molarity} = 6 \div 2$$

$$\text{Molarity} = 3\text{M}$$

### Calculation of Molarity of 37% Hydrochloric acid

$$\text{Specific gravity of HCl} = 1.18\text{g/ml}$$

$$\text{Molecular weight of HCl} = 36.46\text{g/mol}$$

$$\text{Percentage purity} = 37\%$$

$$C = (\text{specific gravity} \times \text{percentage purity} \times 10) \div (\text{molar mass of HCl})$$

$$C = (1.18 \times 37 \times 10) \div (36.46)$$

$$C = 436.6 \div 36.46$$

$$C = 11.97\text{M}$$

$$C_1V_1=C_2V_2$$

$$11.97 \times V_1 = 3 \times 100\text{ml}$$

$$V_1 = 300 \div 11.97$$

$$V_1 = 25.1 \text{ ml}$$

25.1ml of HCl was measured into a 100ml round bottom flask and was filled with distilled water to the 100ml mark.

## **PREPARATION OF 3N SODIUM HYDROXIDE FROM SODIUM HYDROXIDE PELLETS**

Density of NaOH = 2.13g/mL

Molar mass of NaOH = 40g Concentration = 3M

(3N = 3M)

$$n = \frac{g}{\text{molar mass}} \quad g = n \times$$

$$\text{molar mass} \quad g = 3 \times 40g \quad g =$$

$$120g$$

$$\text{Density} = \frac{g}{\text{mL}} \quad \text{mL} = \frac{g}{\text{Density}}$$

$$\text{mL} = \frac{120g}{2.13g/\text{mL}} \quad \text{mL} =$$

$$56.3\text{ml}$$

$$1N \text{ of } 100\text{ml} = 4g$$

$$2N \text{ of } 100\text{ml} = 4g \times 2 = 8g$$

$$3N \text{ of } 100\text{ml} = 4g \times 3 = 12g$$

$$\text{If; } 100\text{ml} = 12g$$

$$\text{Then; } X = 120g$$

$$X = \frac{(120g \times 100)}{12g}$$

$$X = \frac{12000g/\text{mL}}{12g}$$

$$X = 1000\text{ml}$$

In a 1000ml flask, 120g of NaOH was dissolved in 56.33ml of distilled water and then filled to the 1000ml mark with water.

