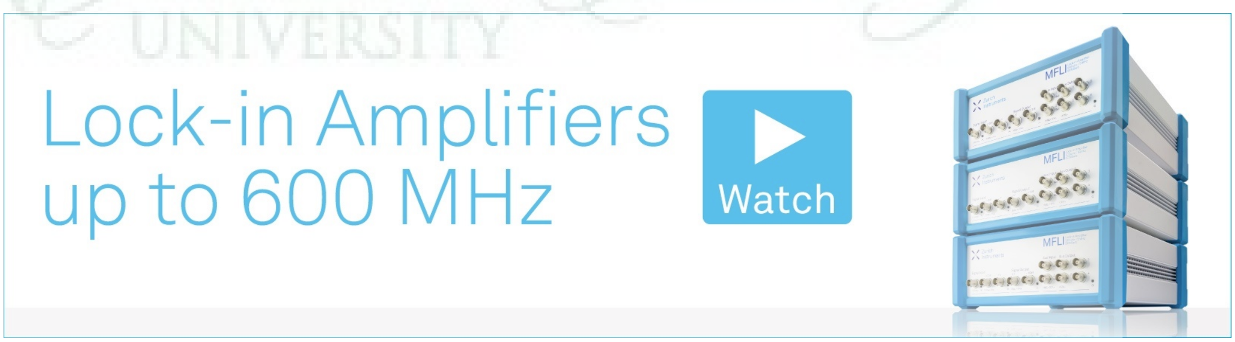
Development of gambir powder as a cheap and green fingerprint powder for forensic applications

Cite as: AIP Conference Proceedings **2155**, 020023 (2019); https://doi.org/10.1063/1.5125527
Published Online: 06 September 2019

Sri Adelila Sari, Hartati Ningsih, Jasmidi, Agus Kembaren, and Naji Arafat Mahat



Development of Gambir Powder As A Cheap and Green Fingerprint Powder For Forensic Applications.

Sri Adelila Sari[1,a)], Hartati Ningsih[1,b)], Jasmidi[1,c)], Agus Kembaren[1,d)] and Naji Arafat Mahat[2, 3, 4,e)]

[1]Department of Chemistry, Faculty of Mathematics and Sciences, Universitas Negeri Medan, 20221 Medan Estate, North Sumatra, Indonesia.
[2]Department of Chemistry, Faculty of Science, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia.
[3]Enzyme Technology and Green Synthesis Research Group, Department of Chemistry, Faculty of Science, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia.
[4]Centre for Sustainable Nanomaterials, Ibnu Sina Institute for Scientific and Industrial Research, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia.

Corresponding author: [a)] sriadelilasari@unimed.ac.id; [e)] naji@kimia.fs.utm.my
[b)]hartatiningsih1505@gmail.com
[c)]jsjasmidi@gmail.com
[d)]kembarenagus@gmail.com

Abstract. Being one of the useful and robust forensic evidence, fingerprints have been widely recognized as the primary human identification tool in forensic investigations. Latent or invisible fingerprints are commonly found at the scenes of crime and thus require the use of visualization methods. Among the established routine operational visualization method is the use of commercially available fingerprint black/white powder dusting. However, although the method is relatively fast, simple and cheap, such a method may poses harmful threats and health hazards towards the users due to the use of fine particles like titanium dioxide, lead- and mercury-based powders. This study proposes a cheap and relatively greener fingerprint powder from gambir plants. The findings revealed that gambir powder is capable of visualizing latent fingerprints on dry, non-porous surfaces. Further study revealed that the quality of gambir-visualised fingerprints were influenced by the particle size of finely ground gambir powder, as well as the types of non-porous surface used. While relatively coarse gambir powder (0.250mm) was more suitable for fingerprints on glass slides and transparent plastics, finer particles of 0.125mm was considerably better for plastic cups, compact discs and aluminium foils. Hence, the findings reported here may serve as stepping stones for future study exploration into greener fingerprint visualization technology.

INTRODUCTION

A fingerprint is an impression of the friction skin ridges of fingers upon contact with an object or surface. Being remarkably unique to only an individual, fingerprint is essentially used as a primary robust human identification tool in forensic investigations [1]. Forensically, fingerprints can be categorised into three different classes: visible, plastic and latent. It has been reported that latent fingerprints are the most commonly found at the scenes of crime [2] and due to its invisibility, such prints often require the use of enhancing tools like powder dusting.

Powder dusting technique has been widely applied in criminal investigations for more than a century, making it the oldest, established, physical fingerprint visualisation method [3]. Furthermore, said technique has become quite the popular go-to method to visualise fingerprints due to it being inexpensive, simple and fast [4-5]. The efficiency of such said method depends largely on the mechanical adherence of powder and general constituents of fingerprints [4, 6-7]. At present, a wide range of powder dusting variants have been introduced to manifest the utmost contrast and quality between the visualised fingerprints and the dry, non-porous object/surface. Black (carbon-based) and white (titanium-based) powders are the two most colour variants of powder dusting that are routinely used in visualising latent fingerprints. However, some of the chemicals used in the powders pose harmful threats and carcinogenic hazards towards the users. For instance, the International

Proceedings of the 2nd International Conference on Biosciences and Medical Engineering (ICBME2019)
AIP Conf. Proc. 2155, 020023-1–020023-5; https://doi.org/10.1063/1.5125527
Published by AIP Publishing. 978-0-7354-1900-1/$30.00

Agency for Research on Cancer (IARC) has concluded that exposure to titanium dioxide (white powder) may possibly induce cancer in humans [8]. In addition, the commercially available lead- and mercury-based powders may also pose health hazards towards the user over prolonged usage [5]. Considering such health hazards, it is therefore imperative to explore a greener alternative with comparable efficiency in visualising latent fingerprints on dry, non-porous surface.

Traditionally used as a natural herb, gambir is extracted from the leaves and twigs of *Uncaria gambir* Roxburgh plants, which are native to Sri Lanka, Indonesia and Malaysia [9]. Besides being commonly used as remedy to relieve inflammatory skin condition and headaches, gambir, ranging from yellow to brown, is also used as textile dyes and tanning agents [10]. Due to its notable properties of non-toxic, easily and widely available as well as simple production, this research is aimed at developing a naturally occurring, cheap and green fingerprint powder from gambir plants for visualising latent fingerprints on dry, non-porous media like aluminium foil, glass, plastic cups, compact discs and transparent plastics.

METHODOLOGY

Materials and Apparatus

Gambir from the fruit part of *U. gambir* plants (purchased from a traditional market in Medan), mortar and pestle, sieve, feather brush, latex gloves as well as five non-porous study materials (aluminum foils, glass slides, plastic cups, compact discs, transparent plastics).

Preparation of Gambir Powder

Using a mortar and pestle, approximately 500g of gambir was ground to fine powder before being sifted through sieves of different particle size (0.250mm, 0.177mm, 0.149mm and 0.125mm with designation numbers of 60, 80, 100 and 120, respectively). The finely ground gambir powder of different particle sizes were then stored in different, labelled air-tight containers until further use.

Preparation and Visualisation of Fingerprint Samples

A total of sixty groomed fingerprints from consented donors were deposited on five dry, non-porous study materials (*viz.* aluminium foils, glass slides, plastic cups, compact discs and transparent plastics). For each type of dry, non-porous study material and sieve particle size, triplicate of fingerprint samples were taken and individually labelled. The protocols for collecting the groomed fingerprints were referred to that of [11] and [12]. Once deposited, the fingerprints on the dry, non-porous study materials were then left open on a laboratory bench at room temperature (28 – 30°C) for up to 2 hours. The fingerprints were then visualised using different particle sizes of finely ground gambir powder, and subsequently photographed. Using the prevailing Centre for Applied Science and Technology (CAST) absolute scale suggested by previous researchers [13], the quality of the gambir-visualised fingerprints was graded accordingly.

RESULTS AND DISCUSSIONS

Visualisation of Fingerprints Using Finely Ground Gambir Powder

The feasibility of newly developed gambir powder as a greener alternative form of fingerprint powder was investigated in this present research. While all of the non-porous study materials were chosen to mimic the metallic and glossy surface of weapons (e.g. knives and glasses) or commonly found evidence at the scenes of crime, the fingerprint samples were intentionally groomed to resemble the natural act of touching the face and/or other hairy parts of the body (e.g. arms).

From the observation, it is evident that the finely ground gambir powder was able to visualise fingerprints on dry, non-porous study materials like aluminium foils, glass slides, plastic cups, compact discs and transparent plastics as showed in Figure 1 (a-e). Based on the clarity of fingerprint ridges, the quality of the gambir-visualised fingerprints were graded based on the suggested CAST absolute scale [13]. Observably, the quality of gambir-visualised fingerprints were of CAST absolute scale of 4 (over 2/3 clear ridge detail) probably due to the sebum-rich content of groomed fingerprints, indicating that this newly developed method works especially best for fresh prints on dry, non-porous surfaces. Because the particle size of gambir powder may affect the quality of visualised fingerprints, such factor was also investigated in this present research.

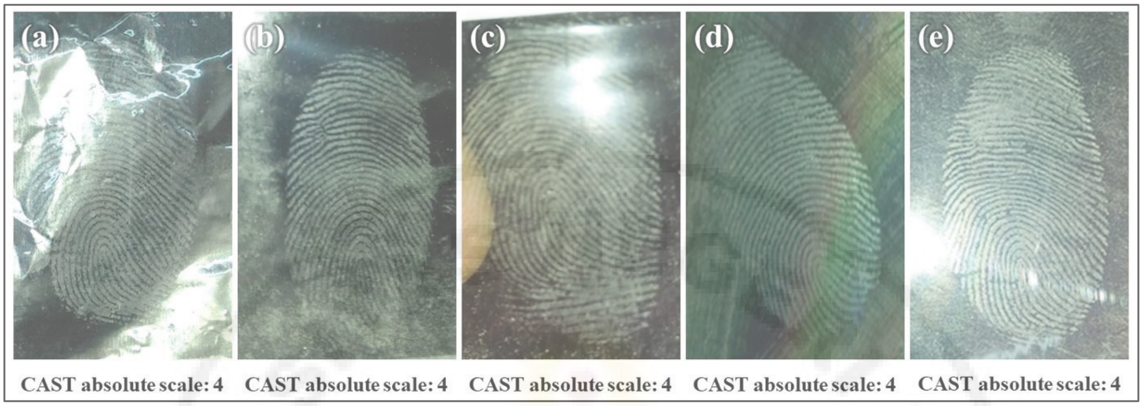


FIGURE 1. Representative photographs of gambir-visualised fingerprints on (a) aluminium foil, (b) glass slide, (c) plastic cup, (d) compact disc and (e) transparent plastic.

Effect of Gambir Powder Particle Size on Quality of Visualised Fingerprints

To investigate the effect of the gambir powder size on the quality of visualised fingerprints on dry, non-porous surfaces, the gambir powder was first sieved using 0.250mm (60), 0.177mm (80), 0.149mm (100) and 0.125mm (120) sieves. Results revealed that the quality of visualised fingerprints on glass slides and transparent plastics using 0.250mm sieve appeared better compared to the quality of visualised fingerprints using gambir powder of particle sizes 0.177mm, 0.149mm and 0.125mm. While CAST absolute scale of 2 can be defined as 'less than 1/3 clear ridge detail', scale of 3 can be designated as 'between 1/3 and 2/3 clear ridge detail' [13]. Such an observation suggested that relatively coarse gambir powder were best applied for surfaces like glass slides and transparent plastics. In addition, the lower quality of visualised fingerprints on glass slides (CAST absolute scale: 2) when compared to that of transparent plastics (CAST absolute scale: 3) may be attributable to the glassy and relatively smooth surface of glass, hence resulting in weaker adherence of sebum-rich fingerprint constituents onto the surface which subsequently had affected the attachment of gambir powder. Representative photographs of visualised fingerprints on both glass slide and transparent plastic using gambir powder of particle size 0.250mm are shown in Figure 2.

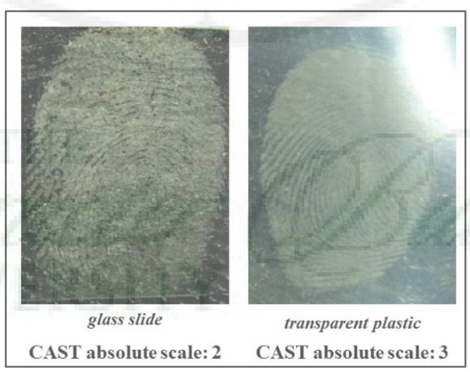


FIGURE 2. Representative photographs of visualised fingerprints on glass slide and transparent plastic using gambir powder (0.250mm).

As for fingerprints deposited on plastic cups, compact discs and aluminium foils, finer particle size of gambir powder (0.125mm) was seen to be more effective in visualising latent fingerprints than the coarse ones. This observation concurred with previously reported research [14] whereby the authors reported better quality of visualised fingerprints on porcelain dishes and glass slides using 33µm of (Fe_3O_4)-based magnetic powder than that of 78µm ones. Likewise results observed for glass slides and transparent plastics, the qualities of visualised fingerprints for plastic cups, compact discs and aluminium foils (CAST absolute scales of 2, 3 and 4, respectively) were increased in accordance with the increased 'roughness' of the respective surface area (plastic cups < compact discs < aluminium foils) (Figure 3).

FIGURE 3. Representative photographs of visualised fingerprints on plastic cup, compact disc and aluminium foil using gambir powder of particle size 0.125mm.

Although this newly developed method proved to be feasible in visualising latent fingerprints on several dry, non-porous surfaces, the implementation of appropriate and suitable fingerprint protocols suggested by the International Fingerprint Research Group [13] for developing new fingerprint visualisation method may further reveal its true worth. Additionally, because visualisation of full fresh and/or groomed fingerprints may lead to erroneous interpretation on the performance of this newly explored method, this necessitates method comparison with the established, routine operational methods like the commercially available fingerprint black powders, a matter of future study.

CONCLUSION

In a nutshell, this naturally occurring, cheap and greener method of fingerprint gambir powder dusting is capable of visualising latent fingerprints on dry, non-porous surface. Findings of this research revealed that while relatively coarse gambir powder (0.250mm) were more suitable for surfaces like glass slides and transparent plastics, fine powders of 0.125mm proved to be excellent in visualising latent fingerprints on plastic cups, compact discs and aluminium foils. Additionally, following the IFRG guidelines and protocols in assessing the actual performance of gambir powder for visualising latent fingerprints on dry, non-porous surface should form an enticing prospect of future study.

ACKNOWLEDGEMENTS

The authors would like to extend our gratitude to the Chemistry Laboratory, Faculty of Mathematics and Science, State University of Medan and Forensic Laboratory of North Sumatra Regional Police. The authors also acknowledged the consented fingerprint donors for enabling this present research to be undertaken.

REFERENCES

1. R. Saferstein, *Forensic science: From the crime scene to the crime lab* (Pearson, New Jersey, 2013) pp. 161
2. H. J. Kobus, K. P. Kirkbride and M.A. Raymond, "Identification: Fingerprints a Key Identification Parameter – Detection, Identification, and Interpretation" in *Encyclopedia of Forensic and Legal Medicine*, edited by (Elsevier Ltd., Netherlands, 2016). pp. 65
3. B. Yamashita, M. French, S. Bleay, A. A. Cantu, V. Inlow, R. Ramotowski, V. Sears and M. Wakefield, "Latent Print Development" in *The Fingerprint Sourcebook*, edited by B. Yamashita and M. French (CreateSpace Independent Publishing Platform, Washington, DC, 2011) pp. 7
4. C. Lennard, Aust. J. Forensic Sci. **39**(2), 55-71 (2007)

5. H. M. Daluz, *Fundamentals of Fingerprint Analysis*. (CRC Press, Florida, 2014)
6. G. S. Sodhi, Kaur, Egypt J. Forensic Sci. **120**, 172-176 (2001)
7. R. S. Ramotowski, *Lee and Gaensslen's advances in fingerprint technology*. (CRC Press, Florida, 2012)
8. International Agency for Research on Cancer. "IARC monographs on the evaluation of carcinogenic risks to humans" in *Carbon black, titanium dioxide and talc*, edited by (WHO Press, Geneva, 2010) pp. 193
9. Y. Zhao, Y. H. Kim, W. Lee, Y. K. Lee, K. T. Kim, J. S. Kang, J. Pharmaceut. Biomed. **117**, 73-78 (2016)
10. T. Anggraini, A. Tai, T. Yoshino, Afr. J. Biochem. Res. **5**(1), 33–38 (2011)
11. S. Jaroensuk, S. Riengrojpitak, and S. Chalermsooksant, "Recovery of latent fingerprints after lifting with water soluble tape" in *Proceedings of the 4th CIFS Academic Day*. (Bangkok, Thaniland, 2009) pp. 27-31
12. R. K. Garg, H. Kumari, R. Kaur, Egypt J. Forensic Sci. **1**, 53-57 (2011)
13. International Fingerprint Research Group. Guidelines for the assessment of fingermark detection techniques. J. Forensic Identif. **6**(2), 346- 359 (2014)
14. S. Gürbüz, B. O. Monkul, T. Ipeksac, M. G. Seden, M. Erol, J. Forensic Sci. **60**(3), 727-736 (2015)