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PLANT WASTE: A SUSTAINABLE SOURCE FOR FINGERPRINT DEVELOPMENT

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Abstract: Powder dusting is one of the oldest methods used in forensic science for detecting latent fingerprints on non-porous surfaces. The latent fingerprint visualization from chemicals is toxic and poses potential health hazards. Large quantities of plant waste are generated during the consumption and processing of fruits and vegetables. Waste management is an upcoming crisis faced by the world. The environmentally friendly disposal of plant waste is a challenging task. Properly managed and utilized plant wastes are a natural resource that can produce economic returns. Plant waste can produce biofuels, fertilizers, and decorative items. In the present study plant wastes are made into a powder form for the development of cheaper and more effective latent fingerprint powder for superior visualization. The biochar production from plant wastes by pyrolysis is achieving immense attention and supplying biochar sustainably. Chemically it is a

char black carbon that contains a large fraction of organic matter. The current study is proposing a new powder method, which is effortless, non-toxic to human health, inexpensive, and simple in nature, and can also be utilized to improve soil fertility. Biochar strengthens the growth of plants by preventing the roots from getting affected by pathogens. In this study, four different plant wastes such as dried leaves of the Peepal tree (Ficus religiosa) are collected to produce biochar for fingerprint development. Biochar is a solid, carbon-rich product that gets mechanically adhered to the sweat residue defining the ridge pattern.

Keywords: Powder, Plant waste, Latent fingerprint, Biochar, Peepal tree.

INTRODUCTION

Forensic science involves the use of scientific methods and methodology to examine, interpret, and understand the remains of past criminal activities[1]. Fingerprints are considered one of the most valuable types of physical evidence found at crime scenes[2]. They are the most important and acceptable evidence in the court of law for accurately identifying the authenticating of an individual. Fingerprints are often found in violent crime cases and can be used as powerful evidence[3]. Latent fingerprint detection and visualization are important aspects of forensic science[4]. Fingerprint consists of unique ridge patterns that differ in every individual[5]. The human body possesses the following three types of sweat glands- eccrine, apocrine, and sebaceous, the secretions of which contribute to a fingerprint deposit[6]. The eccrine glands compose the majority of the sweat glands located on the fingers and palm region[7]. A latent fingerprint is produced when the sweat pores of the papillary ridges leave a deposition of perspiration on a surface with which the finger has been brought into contact[8]. When the complex secretions accumulate on a surface that is nearly 99% made of water, it will evaporate rapidly from the deposit, and then the print becomes dry. This process begins to change certain reagents' ability to envision the print. Therefore, fingerprint powders are the best method to develop a dry latent print on different non-porous surfaces[9]. When the fingerprint powder is sprinkled over the latent print with the help of a brush, the powder adheres to the oil, sweat, or other materials left in a fingerprint[10]. However, the most widely used fingerprint detection method at the scene of a crime is that of fingerprint powdering[11]. A range of different powders such as charcoal powder, magnetic powder, iron flake powder, and luminescent powder, are commercially available[12,13.] The current method uses biochar for latent fingerprint enhancement which is simple, effortless, cost-effective, and non-toxic in nature and made up of plant waste. A wide range of plant waste is suitable as feedstock for the production of biochar. Biochar is produced from residual biomasses such as crop residues, manure, wood residues, forest, and green wastes using advanced pyrolysis technology. Plant waste includes straw, bark, husks, seeds, peels, bagasse, sawdust, nutshell, wood shavings, animal beds, and corn cobs and corn stalks, etc[14,15]. Biochar is used as a means of remediating

contaminated agricultural soil, improving soil fertility by reducing acidity, increasing crop productivity and the amount of nutrients present in soil[16,17] also reducing the need for fertilizers[18]. Biochar is made up of different elements such as carbon, hydrogen, sulfur oxygen, and nitrogen as well as minerals in the ash fraction. It is produced during pyrolysis, thermal decomposition of biomass such as wood, manure, and leaves in a limited oxygen supply environment[19]. Hence in the present study, we are interested in developing latent fingerprints using dried leaves of peepal tree (Ficus religiosa) on different non-porous surfaces. A Muffle Furnace is an alternative heating approach to convert organic waste material into value-added products, such as biochar that can be widely used for environmental applications. The muffle furnace is a sustainable, cost-effective, and environmentally friendly route in the development of biochar from plant waste. It is expected that biochar is non-toxic to human health and effectively used to visualize latent fingerprints.

Need for biochar used as fingerprint development powder

The primary reason for the need for alternative fingerprint powders is the numerous health hazards posed by conventional fingerprint powders during occupational exposure[20]. Heavy metal toxicity, is a significant health concern for forensic and law enforcement personnel who work with inorganic fingerprint powders[21]. Apart from toxicity threats, a good fingerprint powder formulation needs to satisfy some important criteria, which are listed as follows.

1. The powder should be stable and should possess a long shelf life.
2. The powder formulation should not contain any toxic ingredients.
3. The powder should not be too expensive.
4. It is preferable if the powder is made up of readily available common ingredients.
5. The particles of the powder should be fine and small.

MATERIAL AND METHODS

To experiment different non-porous surfaces such as table (sun mica glossy), CD, glass, plastic, and transparency were chosen. Latent fingerprints of some individuals were collected on the substrate under ambient environmental conditions. The experiments were carried out in the department of Dr. A.P.J Abdul Kalam Institute of Forensic Science and Criminology, Jhansi, between the month of March to April when the temperature varied from 25^{o}C to 40^{o}C and the relative humidity between 15% to 30%.

Preparation of Biochar

In this study, we have developed new fingerprint powders using plant waste. To do so, plant wastes were collected from different places. Plant waste includes dried leaves of peepal tree (Ficus religiosa). 10gm of leaves sample was washed to remove dust and dirt and then sun-dried. After that dried leaves were loaded into the muffle furnace and heated up to 100◦ C for 15 minutes. The biochar samples were powdered and sieved by using a muslin cloth.

Development of Latent Fingerprint

Eleven latent fingerprints were collected on each different surface which includes non-porous surfaces such as aluminum sheet, carbon paper, writing surfaces of CD, mirror, painted steel, newspaper, petri dish, plastic bottle, surfaces of water bath (steel), transparency sheet, wooden surface and microscope slide The test latent prints were collected with sebum mainly from the face and forehead. The fingerprints from the donor were deposited on various surfaces. First, the donor's hand was cleaned with water and soap. Next, the hand was allowed to dry for half an hour before deposition. The latent impressions were made by pressing the thumb on each surface. The surfaces were kept at room temperature facing the ceiling, and exposed to dust and air conditioning. The method used for the development of latent fingerprints using biochar is powder dusting which is a physical method. This method involves the application of finely divided particles that will physically adhere to the aqueous and oily components in the latent print residue of the thumb on surfaces. The prints that are developed rated and marked a score between 0-3 based on the quality of print:

0 = No ridge detail will be found

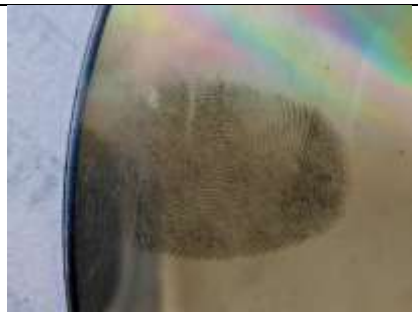
1 = Few ridge details were found (Between 1 and 8 positive point of ridges)

2 = Sufficient ridge details were found to allow identification (between 9 and 14 positive points of ridges)

3 = Very good fingerprint quality for automated fingerprint identification system (AFIS) (more than 15 positive points of ridges)

S.No.	Fingerprint Surfaces	Ridge details Point

1	 Aluminum Surface	1
2	  Carbon Paper	2

3	 Surface of C.D	3
4	 Mirror	2
5	 Non Painted Steel Surface	2
6		1

	 News Paper	
7	 Petri Dish	3
8	 Plastic Bottle	2

9	 Transparency Sheet	3
10	 Microscope Slide	3

Results and Discussion

The results of the latent fingerprint development using biochar on eleven non-porous surfaces are shown in the figures below. Latent fingerprints present on the majority of the surfaces examined can be successfully developed with biochar.

In this paper, the development of latent fingerprint is employed on non-porous surfaces in the research. The surfaces used which were aluminum sheet, carbon paper, writing surfaces of CD, mirror, non-painted steel surface, newspaper, petri dish, plastic bottle, surfaces of water bath (steel), transparency sheet, wooden surface and microscope slide give a clear latent fingerprint ridges and this proves that the development of latent fingerprint using biochar could be successfully done which were evident from the figures 1-12. The latent prints can be developed with biochar can help law enforcement agencies. Besides, the biochar obtained from plant waste is nontoxic, therefore, it will not harm the user or personal belongings such as water bottles which can still be used after visualisation.

Conclusion

Different forms of plant waste are present everywhere, which are easily available, non-toxic, and simple in nature. This powder method could be successfully used in developing latent fingerprints on various surfaces and in the future, it can be utilized at the crime scene for the development of latent fingerprints.

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