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Full Length Research Paper

Coloured intensity enhancement of latent fingerprint powder obtained from banana peel activated carbon with methylene blue

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This study was aimed at developing activated carbon fingerprint powder derived from banana peel. The obtained powder was then examined for its latent fingerprint identifying capability. First, the banana peel activated carbon powder was ground into fine particles and consequently was sieved using a 400-mesh screen. The powder's adherent quality was evaluated by dusting it to the residue left by the friction ridge skin on the fingers. The materials added and varied to formulate the fingerprint powder were sodium acetate (5.0-25.0%), mineral oil (0.25-2.00%), and methylene blue (0.1-0.3%). The aforementioned powder was also observed for its surface characteristics using SEM to determine the adherence of a finger ridge on a non-porous substrate in comparism to a commercial powder. It was found that the increased addition of sodium acetate and mineral oil significantly improved the powder's capability to adhere to latent fingerprints. The combinations that gave the better fingerprinting quality were formulas with sodium acetate and mineral oil at 20.0 and 2.00%, respectively. Furthermore, an increase of methylene blue in the formula also affected the powder quality. The best friction ridge appearance was from the powder with methylene blue added at dosage of 0.2%.

Key words: Fingerprint powder, banana peel activated carbon, sodium acetate, mineral oil, methylene blue.

INTRODUCTION

Fingerprint has been used to scientifically establish the identity of suspected criminals. The traditional fingerprinting technique is simple, inexpensive, and does not require much experience by the examiners. The powder will collect on the moisture and oil components of latent fingerprint left on a substrate. Fingerprint detection has typically started with optical techniques, and then is followed by physical and chemical processes. An ideal powder provides color with acute contrasting, good adherence properties and desirable sensitivity (Lennard, 2001). Good fingerprint powder will adhere well on sweat residue, which consists principally of moisture and oily components, thereby resulting in a visual contrast of the ridge patterns. The fingerprint powder must not be deposited in the skin furrows and must be brushed off. Some powder manufacturers have incorporated dyes to make the ridge patterns more visible. Most of the dyes used are organic in order to avoid toxic effect to examiners (Sodhi and Kaur, 2001). A study performed by Mopoung (2005) proved that carbonized banana peel with smaller particle size could readily be used to render latent fingerprints. The banana peel was carbonized at a temperature of 500^{o}C, then activated by potassium hydroxide at temperatures between 600-900^{o}C to form vast porosity with fine fibrils. There was also an incorporation of ingredients which are comprised dominantly of ionic compounds similar to the natural secretions from ridge skin i.e. fats or minerals.

This research was intended to focus on the fingerprint powder quality derived from activated banana peel. This research outlined the influences of various concentrations of mineral oil, sodium acetate, and methylene blue on

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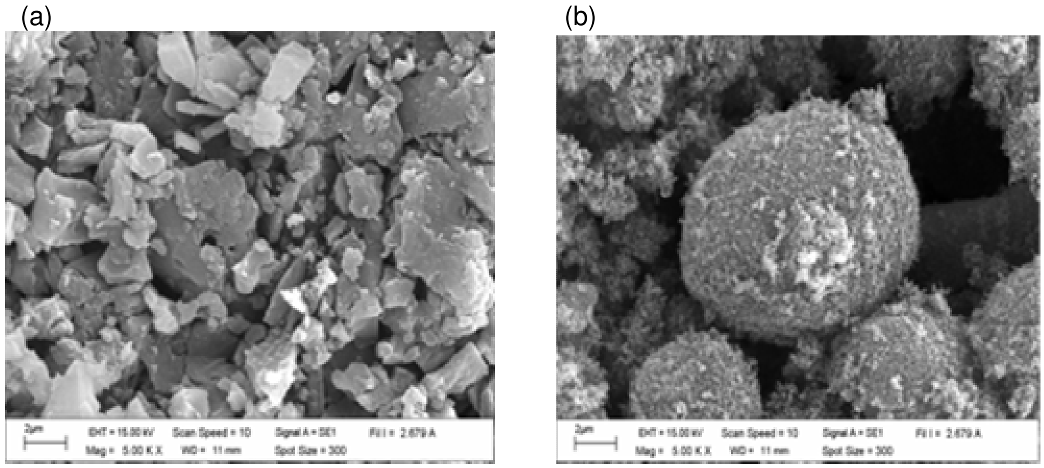


Figure 1. SEM surface images of banana peel activated carbon (a) and commercial latent fingerprint powder (b).

powder quality. The banana peel powder was applied by a brushing method on a non-porous surface to assess its adherence to friction ridges. The comparison was made against the commercial powder in terms of the fingerprint image quality, sensitivity, and adhesion to friction ridges.

MATERIALS AND METHODS

Banana peel activated carbon preparation

Dried banana peel was carbonized at 400^{o}C, and then activated using phosphoric acid (UNIVAR, AR) at a ratio of 0.5:1.0 by volume per weight (phosphoric: dried banana peel carbon). Afterwards, the pyrolysis of the banana peel carbon was performed at 800^{o}C. After cooling down, the activated charcoal was washed successively several times with 5 N HCl (BDH, AR.), 22N HF (MERCK, pro analysi) then with hot water until the pH became neutral, and finally with cold water to remove the excess phosphorous compounds. The washed samples were dried at 110^{o}C to get the final product. The carbon powder was then crunched in a ball mill grinder. The very fine powder was sieved through a 400-mesh screen. A SEM technique (LEO 1455 VP electron microscopy) was used to display the surfaces of the banana peel activated carbon.

Effects of sodium acetate and mineral oil on powder quality

Various dosages of sodium acetate (Fisher Chemical, AR) were added to the powder recipe, from: 5.0, 10.0, 15.0, 20.0, and 25.0 % by weight (added in a aqueous solution form). Subsequently, the recipe was dried at temperature of 105^{o}C for 3 h, followed by the mineral oil (commercial grade) addition at 0.25, 0.50, 1.00, 1.50, and 2.00% by volume to weight (dissolved with lab-grade hexane). Eventually, the recipe was again dried at a temperature of 70^{o}C for 1 h. The finished powder was covered with plastic in order to prevent moisture exposure.

Adhesion property of powder on non-porous substrate

The fingerprinting process was done on glass slide and accomplished from the same volunteer's finger. Each fingerprinting (forehead) was done and left on a 10-min interval basis. Whilst the desired numbers of finger printings was completed, fingerprint dusting using a brush was followed. The powder performance from each powder recipe was judged against the commercial powder (black carbon powder, obtained from the Regional Forensic Science Division 33, Royal Thai Police, Phitsanulok province) using both binocular microscopy (Olympus BH2) and photography (Digital camera, Motic Image, +2.0 ML). The recipe that gave the best friction ridge quality was further subjected to into the next round of testing.

Effect of methylene blue on powder quality

It was found that the best recipe was the one with 10.0% sodium acetate and 2.00% mineral oil. The recipe was mixed together with methylene blue at the ratios of 0.1, 0.2, and 0.3% by weight (as in the aqueous solution form). Shortly after, the drying process was done under a temperature of 105^{o}C for 3 h. The powder adhesion performance versus the commercial powder was tested afterwards. The dusting was accomplished using the brushing method to verify the ridge image appearance.

RESULTS AND DISCUSSION

The surface appearance of banana peel activated carbon versus commercial powder

It is seen in Figure 1 that the particle size of banana peel carbon was in the ranges of 1-6 microns with a truncated shape, whereas the size of the commercial powder was in the ranges of 6-12 microns and had a spherical shape with very tiny fibrils on its surface. Generally, the powder particle size for fingerprinting identification was in the ranges of 1-50 micron (Sodhi and Kaur, 2001).

Effects of sodium acetate and mineral oil on powder quality

From Figure 2, it is found that increasing the amounts of

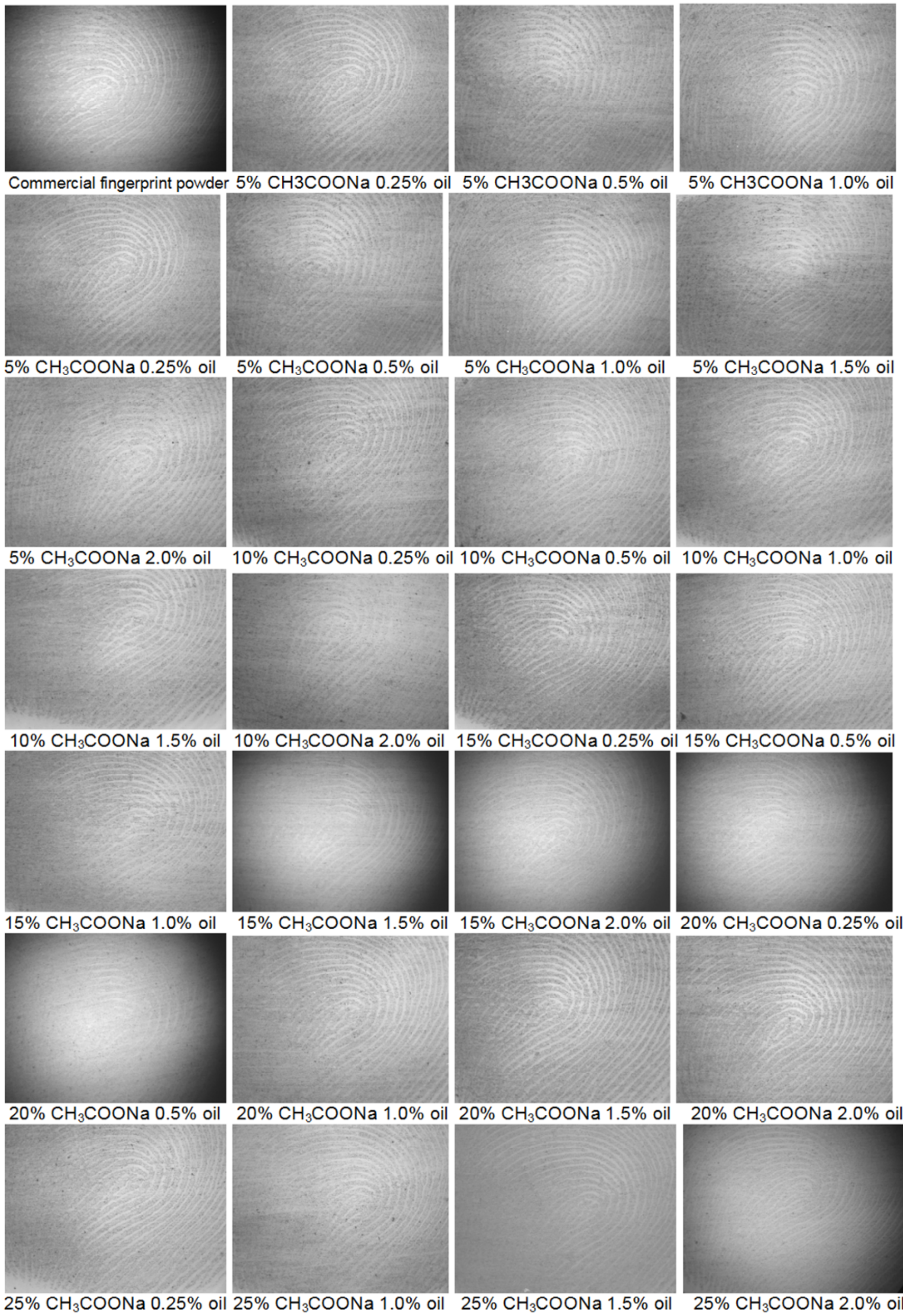


Figure 2. Images (20X) of latent fingerprint pattern on glass slide with powder from commercial latent fingerprint powder and banana peel activated carbon powder with 5.0-25.0% CH_3COONa and 0.25-2.00% mineral oil.

sodium acetate and mineral oil improved the adhesion of the fingerprint powder on the friction ridges on the glass slide, particularly the increase of mineral oil from 0.25 to 2.00%. An increase in the sodium acetate dosage from 5.0 to 25.0% tended to enhance the adhesion of the powder to the friction ridges on the glass slide, but further

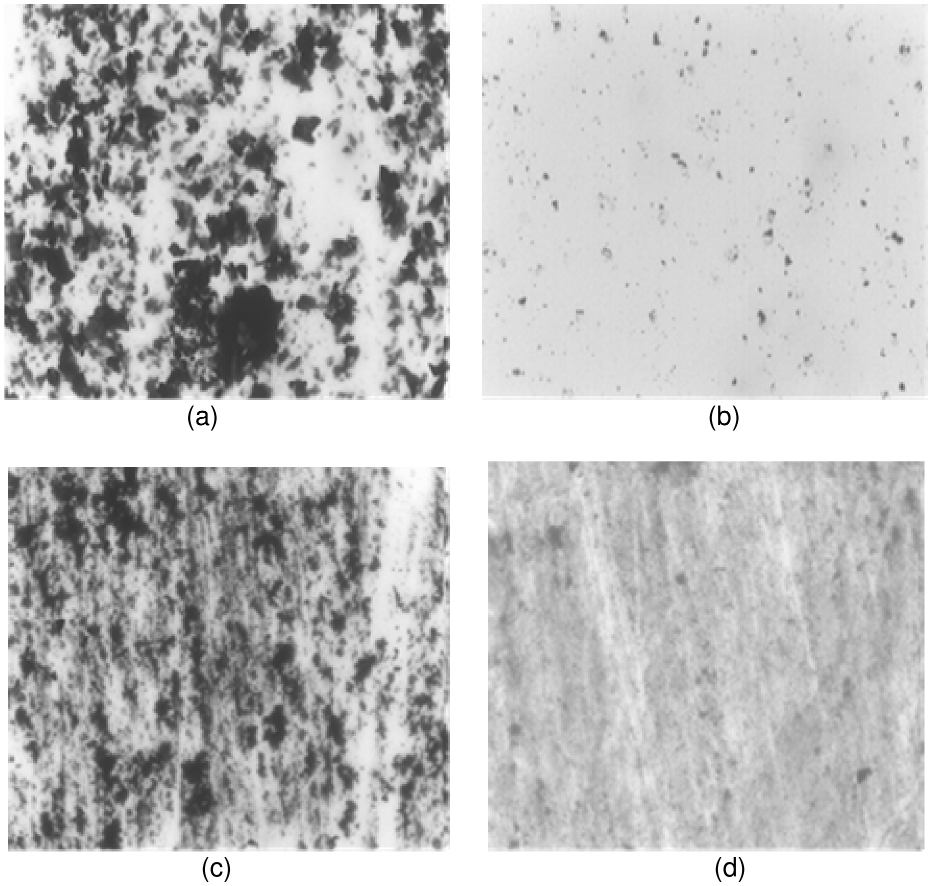
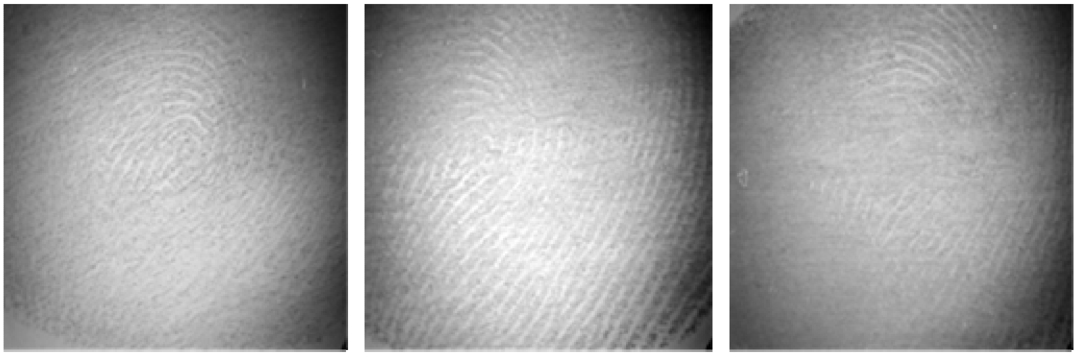


Figure 3. Images (40X) of a latent fingerprint on a glass slide with 20.0% CH_3COONa, 2.00% mineral oil of banana peel activated carbon powder on ridge (a) and furrow (b) of sweat residue compare to a commercial latent fingerprint powder on ridge (c) and furrow (d).

increasing the amounts of sodium acetate yielded a loss of clarity of the latent fingerprint. In comparison to the commercialized powder, the dosages of both mineral oil and sodium acetate at 2.00 and 20.0%, respectively, gave a better fingerprint image. At a higher resolution, the powders were seen adhering on the ridges and furrows (Figure 3). In Figure 3(a) the banana peel powder adhered well on the ridges but never or almost never sticking in the furrows, after the surface was rubbed by a brush. The commercial powder adhered a little better to the ridges (Figure 3(c)), but more adhered in the furrows (Figure 3(d)). This strengthened the findings that banana peel powder was not adhering to the furrows. Sodium acetate had a beneficial effect on powder quality because the inherent organic group (CH_3COO^-) was adsorbed onto the surface of the activated carbon while the Na^+ ion acted as the cationic exchanger (Mugisidi et al., 2007). This could result in a charge formation on the activated carbon surfaces, thereby electronically causing the fixation with moisture, salts, ionic compounds, and polar substances deposited by a latent fingerprint. Mineral oil also aided powder quality, being non-polar, which could bind the oily component deposited by latent fingerprints. An increased amount of mineral oil therefore significantly enhanced the fixation of the powder to the friction ridges. This was explained by Pan et al. (2005) that mineral oil adsorbed onto the powder surfaces consists of two components: an inner zone where polar parts are directly bonded on the polar parts of powder surfaces and an outer zone where oil is non-polar in contact with the oil components of latent fingerprints. This also led to the binding of powder when adding too much mineral oil, causing the need to apply more powder for each dusting and resulting in an unnecessary loss of the powder during latent fingerprinting identification.

Effect of methylene blue on powder quality

The best powder recipe was with 20.0% sodium acetate, 2.00% mineral oil, and mixed with methylene blue at dosages between 0.1 to 0.3 % by weight. It was found that the color intensity was improved with the increased dosages of methylene blue. Methylene blue is literally deep blue. On the adhesion and clarity test of the powder on friction ridges, the best powder recipe was obtained



0.1% MB 0.2% MB 0.3% MB

Figure 4. Images (20X) of latent fingerprint on glass slide with 20.0% CH_3COONa, 2.00% mineral oil and 0.1-0.3% methylene blue (MB) of banana peel activated carbon powder.

from the one with methylene blue at a dosage of 0.2% (Figure 4). Although there was an improvement of powder quality in terms of the fingerprint clarity in the recipe with methylene blue dosage of 0.3%, there was a deterioration in the adhesion of powder on the ridges, which was relatively easy to be rubbed off by brushing. A high quantity of methylene blue in the recipe also caused poor adhesion of the powder to the friction ridges and an impaired cohesion amongst the powder particles was also evidenced. This was because the large molecules of methylene blue hindered adhesion or because the larger molecules were absorbed on the activated carbon surfaces (Khezami et al., 2005) thereby leading to the lowering of the porosity of the carbon which eventually reduced the capability of oil absorption on the latent fingerprint or absorption of powder particles themselves.

Conclusions

Activated carbon powder derived from banana peel was crushed and sieved using a 400-mesh screen and its adherence properties on latent fingerprints on non-porous substrate was determined. Various materials in varying quantities were tested and it was found that the optimum formula was a ratio of 20.0:2.00% of CH_3COONa to mineral oil.

The banana peel powder adhered well to the friction ridges and was easily brushed from the furrows. This gave a better fingerprint 0.2% or slightly less of methylene blue intensified the sharpness and darkness of the fingerprint's appearance.

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