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TECHNICAL NOTE

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Chemical Reagents for the Development of Latent Fingerprints. I: Scope and Limitations of the Reagent 4-Dimethylamino-Cinnamaldehyde

Among the chemical reagents that are currently used for the development of latent fingerprints on paper, ninhydrin is undoubtedly the most common [*1*]. Yet the ninhydrin method suffers from several disadvantages because the reaction is slow and requires heat for complete development. Sometimes the method is misleading because of background reactions [*1,2*], and not all individuals excrete sufficient perspiration to leave latent prints identifiable with ninhydrin [*3*].

In this first part of a comprehensive research program directed towards reagents that may replace ninhydrin for the development of latent fingerprints, we have investigated the scope and limitations of the recently reported 4-dimethylamino-cinnamaldehyde (DMAC) reagent [*4*].

Method

A collection of 1000 latent fingerprints on one type of commonly used white paper (groundwood free) was prepared. The sample was composed of 100 sets of ten fingerprints donated by 100 individuals. Each one of the sets was divided into separate fingerprints, which enabled us to compare the effect of various formulations of DMAC on latent prints taken under identical conditions. This eliminated the possible effect of differences in amount and constitution of the perspiration.

The DMAC reagent was prepared according to the method of Morris [*4*] in various forms that differed by type and concentration of the acids used (see Table 1). The reagent was applied to the paper by either dipping or spraying. A special dark-glass aerosol container was designed for applying the reagent, the solvent being Freon® 113 and the propellant Freon 12.

The Israel police's ninhydrin working solution (which is considered by the Israel police as the most suitable for field work) was used as a reference and was applied from an

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TABLE 1—*The effect of various acids on the development of latent fingerprints with DMAC.*

Test	Acid[a]	Age of Latents	Color of Background (When Exposed to Light)	Quality of Prints[b]	Remarks
1	nitric	24 h	orange	0	score 0 was given when the only result was total coloration of the paper
2	nitric	10 days	orange	0	...
3	sulfuric	24 h	pink	7	...
4	sulfuric	10 days	pink	2	score 2 was given to unresolved stain that differs from the background
5	hydrochloric	24 h	dark yellow	5	...
6	hydrochloric	10 days	dark yellow	0	...
7	formic	24 h	yellow	0	...
8	formic	10 days	yellow	0	...
9	acetic	24 h	dark yellow	0	...
10	acetic	10 days	dark yellow	0	...
11	chloroacetic	24 h	yellow	0	...
12	chloroacetic	10 days	yellow	0	...
13	oxalic	24 h	yellow	7	...
14	oxalic	10 days	yellow	2	...
15	citric	24 h	pink	4	...
16	citric	10 days	pink	0	...
17	4-phenolsulfonic	24 h	pink	6	...
18	4-phenolsulfonic	10 days	pink	0	...
19	sulfosalicylic [4]	24 h	pink	8	same prints with ninhydrin were scored 8, without any background coloration
20	sulfosalicylic	10 days	pink	2	same prints with ninhydrin were scored 8, without any background coloration
21	citric + sulfuric[c]	24 h	violet	8	same prints with ninhydrin were scored 8, without any background coloration
22	citric + sulfuric	10 days	violet	2	same prints with ninhydrin were scored 8, without any background coloration
23	oxalic + sulfuric	24 h	violet	7	...
24	oxalic + sulfuric	10 days	violet	2	...

[a]The concentration of acid was 0.05*M* and that of DMAC 0.0143*M* in a 7:13 mixture (v/v) of ethyl alcohol/Freon 113. The samples were developed by dipping and drying in air for 5 min (for 19 and 21, also by spraying).

[b]The scores are average values for five independent samples.

[c]Concentration of each acid was 0.05*M*.

aerosol can as above. The reagent was prepared according to the method of Morris et al [2].

Comparison of the quality of the developed prints was based on a semiquantitative estimation; a scale of 10 grades of quality was developed, the upper grade, 10, being that of inked prints. Prints that were suitable for comparison by the Israel police fingerprints laboratory were scored from 6 to 10. Prints that were not suitable for comparison received marks of 5 and under. A table based on this method of scoring enabled us to choose only the most promising formulation out of a large number of experiments.

Results and Discussion

Table 1 is a summary of the results obtained with various formulations of DMAC. The main observations were as follows.

1. The better formulations for fast and relatively neat development were 19 and 21, both having a medium-containing combination of a strong and a weak acid (sulfosalicylic acid contains both functions in one molecule).
2. Despite the great variety of formulations that has been tested, a background coloration appeared in all the samples after periods ranging from a few minutes to one day. Even acidity variations [2] did not totally prevent this coloration. The background, however, could be considerably reduced by maintaining the freshly developed prints in the dark for a few days. Also, the presence of the weak organic acid in the mixture seems to slow down the appearance of background coloration.
3. A DMAC solution such as 19 or 21 can be stored in an opaque aerosol sprayer at room temperature for at least a few months without noticeable deterioration.
4. While the quality of ninhydrin-developed prints did not markedly depend on the age of the latents (up to several months), latent prints older than about 72 h showed up with DMAC as unresolved stains. We suggest that this phenomenon can be explained by the diffusion of urea (which is the primer substrate of DMAC) from the ridges. Urea is also known to decompose bacterially, which may enhance the "smudged" appearance of the developed prints.
5. In general, we have not encountered many latent prints that reacted better with DMAC than with ninhydrin.

Conclusions

In view of the experimental results, ninhydrin seems to be the more general and versatile reagent for the development of latent fingerprints on paper. However, DMAC would be preferable for the quick development of relatively fresh (up to 72 h) fingerprints when the application of heat is forbidden or otherwise impossible (for example, on a sheet of paper wrapping an explosive). Under such circumstances the use of an aerosol container would be recommended.

Among the various constituents of human perspiration, urea is apparently not as dependable a substrate for the development of latent fingerprints as are amino acids and peptides.

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References

[1] Morris, J. R. and Goode, G. C., *Police Research Bulletin*, Vol. 24, Autumn 1974, pp. 45–53.
[2] Morris, J. R., Goode, G. C., and Godsell, J. N., *Police Research Bulletin*, Vol. 21, Spring 1973, pp. 31–36.
[3] Crown, D. A., *Journal of Criminal Law, Criminology and Police Science*, Vol. 60, No. 2, June 1969, pp. 258–264.
[4] Morris, J. R., British patent 1423025, 1976.

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