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Effectiveness of Talcum Powder for Decipherment of Latent Fingerprints on Various Substrates

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Decipherment of latent fingerprints are one of the most common tasks in crime scene investigation as it carries the unique identification feature of the individuals related to that offence. Powder dusting is the most suitable method to develop latent prints on a wide range of nonporous and semiporous surfaces. In present work, a commercially available talcum powder, generally used as a common cosmetic product, has been used to decipher latent prints on 28 non-porous and semi-porous surfaces commonly encountered in daily life. The powder is economic and harmless in nature and easily available in market. The results showed that the powder developed good quality fingerprints on most of the surfaces and can be a good substitute of conventional powders.

Keywords: Decipherment, Latent fingerprints, Powder dusting, Talcum powder, Non-porous surface, Semi-porous surface.

INTRODUCTION

Fingerprints are one of the most frequent and historically consistent pieces of evidence, which are often encountered at the scene of the crime. For over 100 years, fingerprints have been used to establish a link between crime and criminals. Personal identification through fingerprints is an important facet of forensic science. Fingerprints as evidence have established their significance, both as exculpatory and inculpatory evidence, throughout history in countless crimes [1-3]. According to Gardner, anything, which tends to prove or disprove a fact under consideration is an evidence [4]. Despite revolutionizing discoveries in the field of DNA for personal identification, fingerprints haven't lost their relevance at all, since they are biologically distinct.

Due to the cautious and deliberate tendency of the perpetrator to escape, most often only latent prints are left at the crime scene [3,5,6]. Latent prints are left over a surface when friction ridges coated with the excretory products of sweat glands, sebaceous glands (face and scalp) and various other contaminants come in contact with that surface [6]. Fingerprint matrix is predominantly composed of sweat with over 98% water content along with around 2% organic and inorganic components including magnesium, iron, zinc, copper, molybdenum, tin, cobalt, manganese, sulphur, mercury, iodide, bromide, urea, phosphate, proteins, lipids, fatty acids amino acids, cholesterol, *etc.* [6,7].

Discovering and developing a latent print is a sophisticated task in a crime scene investigation due to the enormous diversity of surfaces on which prints may be found. Generally, three methods *i.e.*, powder dusting, fuming and chemical development are used to develop latent fingerprints on a wide range of surfaces which may be commonly classified as non-porous, porous and semi-porous surfaces [6]. Powder dusting is a superlative method for fingerprint development on both non-porous and semi-porous substrates on account of their low surface adsorptivity [6]. The fundamental principle behind the powder dusting method is the adherence of powder particles with the fingerprint residues [3,5,8]. Previous researches [3,9] have shown that the particle size of powder is inversely proportional to its efficiency of adherence. In past, numerous researches [3,5,7-22] had carried out the investigation of the efficacy of various conventional and non-conventional powders in the development of latent prints. A list of different non-conventional powders used for latent print development on a variety of non-porous and semi-porous surfaces is shown in Table-1.

In present study, the efficacy of commercially available talcum powder was investigated to decipher latent fingerprints

TABLE-1
COMPARISON OF THE PRESENT STUDY WITH PREVIOUS STUDIES ON LATENT FINGERPRINT DEVELOPMENT BY NON-CONVENTIONAL POWDERS ON DIFFERENT SURFACES

Powders	Surfaces	Ref.
Turmeric powder	Simple paper, bond paper, thermal paper, sun mica, plastic, transparent sheet, aluminium foil, painted sheet, top surface of CD, writing surface of CD	[4]
Food and festival colors	Paper, aluminium foil, aluminium sheet, CD	[10]
Silica gel G	Carbon paper, match box, card board, plastic bottle, transparent sheet, gift wrapping paper, plain glass, brown bottle glass, mirror, perfume can, currency coin, aluminium foil, gloss painted wood, top surface of CD, writing surface of CD	[6]
Robin blue powder	Touch screen of smartphone (Corning Gorilla Glass), phone back (plastic), credit card (front), Magnetic strip of credit card (back black portion), pen drive (white and black), computer mouse, computer keyboard (spacebar), metallic door knob, glass, steel cupboard (painted surface), lock, stainless steel, silver surface, keychain, electric switch, currency coin, glossy laminated cover page, simple paper, multicolored glossy paper, wooden door, plastic petrol can, plastic water bottle, inner surface of rubber glove	[3]
Baking powder; Gram Flour; Corn powder; chocolate powder; Dry ginger powder; Refined wheat powder; Ranipa; Custard powder; Dry mango powder; Neel powder.	Aluminium foil, CD, glass, plywood, fiberglass, transparency sheet, aluminium can	[11]
Turmeric powder; Cumin powder; Garam masala, Limestone, Gram Flour, Coriander powder	Aluminium foil	[19]
Talcum powder	Aluminium foil, Copper plate, Currency coin, Door latch, Lock, Steel Plate, Eyeglass, Smartphone touchscreen guard, Smartphone touchscreen, Computer keyboard, Front side of debit card, Laminated cover of book, Magnetic strip of debit card, Computer mouse, Pen drive, Plastic container body, Plastic container cap, Electric switch, Smartphone back cover, Transparent plastic bottle, Marble, Tile, Match box, Porcelain mug, Gloss painted wood, Rexine bag, Nitrile gloves, Non-adhesive side of transparent tape	Present study

on four different classes of surfaces *i.e.*, metal, glass, plastic and miscellaneous. Talcum powder consists of talc as its main ingredient, which is composed of magnesium, silicon and oxygen. Talcum powder is commonly used in cosmetic products for reducing friction and absorbing moisture keeping the skin dry and rashes free in humid conditions. In its natural form talcum powder contains asbestos, which does have carcinogenic effect [23,24]. The powder used in the present study contains calcium carbonate, titanium dioxide, talc ($Mg_3Si_4O_{10}(OH)_2$), aluminium starch octenylsuccinate ($C_{18}H_{28}O_9Al_{1/3}(C_6H_{1005})_n$), magnesium stearate, mica ($XY_{2-3}Z_4O_{10}(OH, F)_2$ with X = K, Na, Ba, Ca, Cs, (H_3O), (NH_4); Y = Al, Mg, Fe^{2+}, Li, Cr, Mn, V, Zn; and Z = Si, Al, Fe^{3+}, Be, Ti), alumina (Al_2O_3), silica (SiO_2), perfume, vinyl dimethicone crosspolymer. Some ingredients of the powder have been used individually in some studies for developing latent print [7,20-22]. Present study is the earliest attempt to explore the efficiency of talcum powder as a mixture of multiple powders/components for the development of latent fingerprints.

EXPERIMENTAL

In present study, the fingerprints were obtained from six randomly selected healthy individuals (age: 21-25 years). All the subjects were free from any disease or pathological disorder and thoroughly demonstrated about the nature and purpose of this study. All the prints were collected according to the procedure recommended by the International Fingerprint Research Group (IFRG) in their guidelines [25]. Prints were deposited in natural conditions without any deliberate grooming by keeping the palm in fist position or rubbing the finger on the cheek or nose. No handwash was preferred before obtaining the prints. All the subjects were asked to press the surfaces with their fingers as they used to do it in daily routine to hold or pick up any substance. The above-mentioned procedures were followed to mimic a real-life situation of fingerprint deposition on various substrates. Deposited prints were left undisturbed for approximately 28 h in normal room conditions. The month of November was selected for the present experiment because the range of variation in the relative humidity and temperature was very high this month. During the study, the temperature ranged from 30 ºC to 15 ºC and relative humidity between 94% to 37%.

A commercially available talcum powder (commercial name: white tone) manufactured by Athene Laboratories (Nahan Gadh, Sirmaur, India) was used to develop the latent fingerprints in the present study. The powder dusting method was applied by using a soft camel hairbrush. The powder was gently sprinkled over the 28 different surfaces selected for the present study, containing the latent prints. Face mask and hand gloves were used as a precaution. For each surface, the development procedure was repeated five times with an interval of two days to avoid intra-developer and inter-developer errors. Developed prints were photographed by NIKON D3400 (24.2MP-AF-P DX NIKKOR 18-55 mm lens kit) DSLR (Digital Single Lens Reflection) camera. All photographs were cropped and resized by using 'Adobe Photoshop CC' software.

Procedure: A numerical quality assessment scale was created according to the qualitative numerical scales given in IFRG guidelines. Various factors (background noise, smudging and contrast) affecting the visibility of a good print were considered while giving the values to the developed prints. Table-2 describes the numerical values assigned according to the quality of the developed prints.

TABLE-2
DESCRIPTION OF NUMERICAL VALUES ASSIGNED TO THE DEVELOPED FINGERPRINTS (IFRG GUIDELINES)

Grade	Quality of print developed
4	More than 2/3 clear ridge detail
3	Clarity of ridge detail between 1/3 and 2/3
2	Clarity of ridge detail is less than 1/3
1	Some evidence of a fingerprint
0	No fingerprint developed

Twenty-eight non-porous and semi-porous surfaces categorized into four classes based on their nature and material composition *i.e.* metal, glass, plastic and miscellaneous (Table-3). Out of these 28 surfaces, six were metal surfaces, three were glass surfaces, eleven were plastic surfaces and the remaining eight surfaces were categorized as miscellaneous surfaces.

RESULTS AND DISCUSSION

The present study was conducted to explore the efficacy of commercially available talcum powder for the development of latent fingerprints on 28 commonly encountered surfaces around us. Figs. 1-4 shows the developed fingerprints on four different classes of surfaces.

The powder was found to be a good alternative of conventional powders commonly used in different forensic science laboratories, to decipher latent prints on a variety of surfaces. More than 2/3 clear ridge details were observed on fingerprints developed on transparent plastic bottle, non-adhesive side of transparent tape, plastic bottle cap, laminated book cover, magnetic strip of debit card, glossy painted wood, plastic switch, smartphone touchscreen, spectacle, smartphone touchscreen

TABLE-3
LIST OF ALL THE SUBSTRATES IN THEIR RESPECTIVE CLASSES, USED FOR THE FINGERPRINT DEVELOPMENT BY TALCUM POWDER

Surface	Articles
Metal	Aluminium foil, copper plate, currency coin, door latch, lock, steel plate
Glass	Eye glass, smartphone touchscreen guard, smartphone touch screen
Plastic	Computer keyboard, front side of debit card, laminated cover of book, magnetic strip of debit card, computer mouse, pen drive, plastic container body, plastic container cap, electric switch, smartphone back cover, transparent plastic bottle
Miscellaneous	Marble, tile, match box, porcelain mug, gloss painted wood, non-adhesive side of transparent tape, nitrile gloves, rexine bag

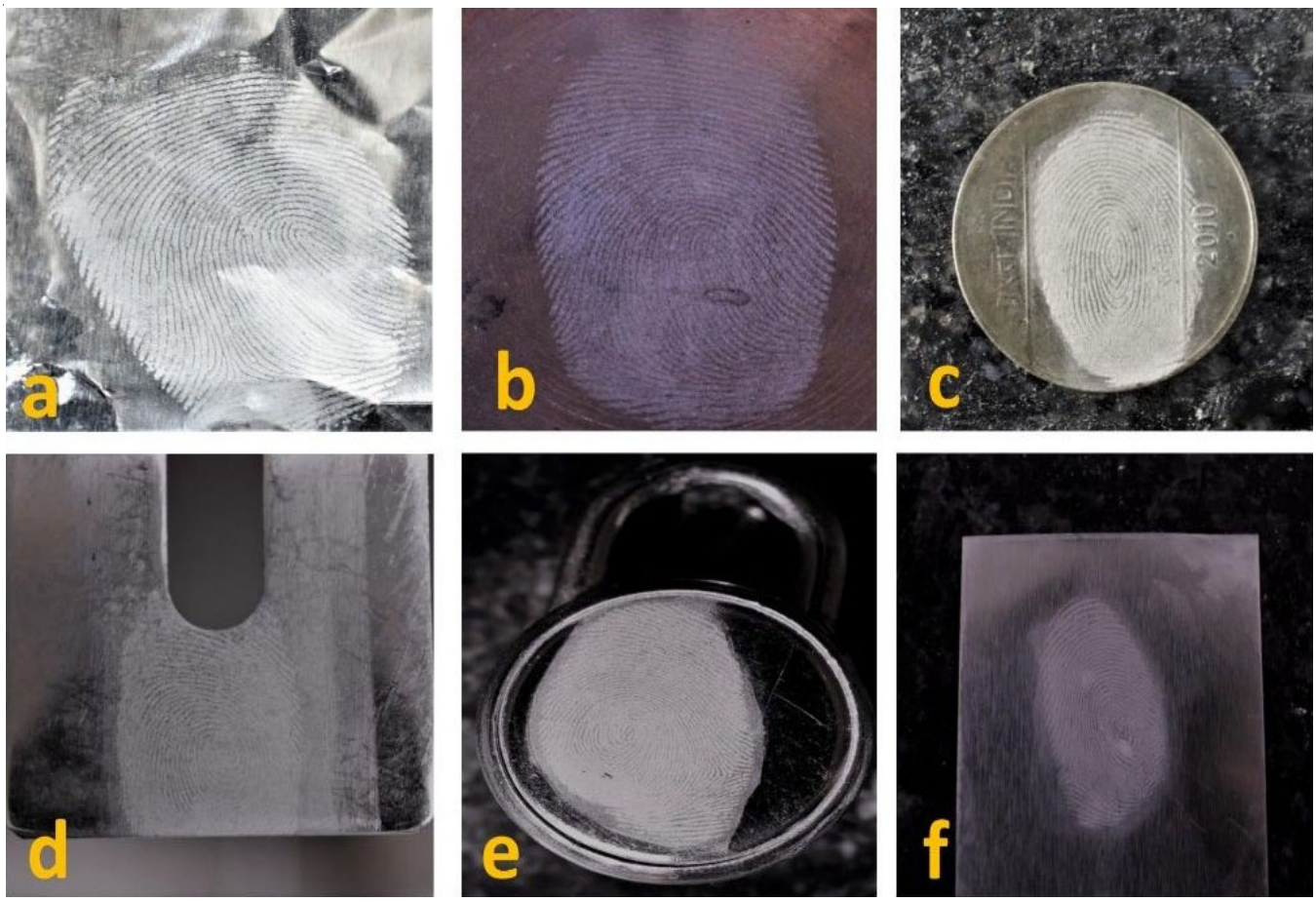

Fig. 1. Developed fingerprints on different metallic surfaces (a) aluminium foil (b) copper plate (c) currency coin (d) door latch (e) lock (f) steel plate

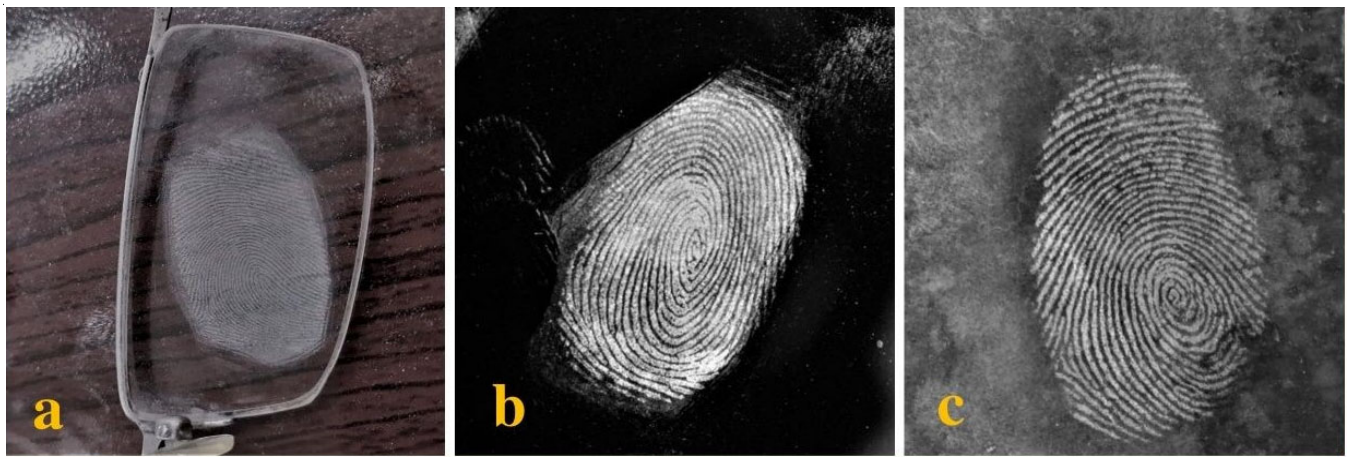

Fig. 2. Developed fingerprints on different glass surfaces (a) spectacle (b) smartphone touchscreen (c) smartphone touchscreen guard

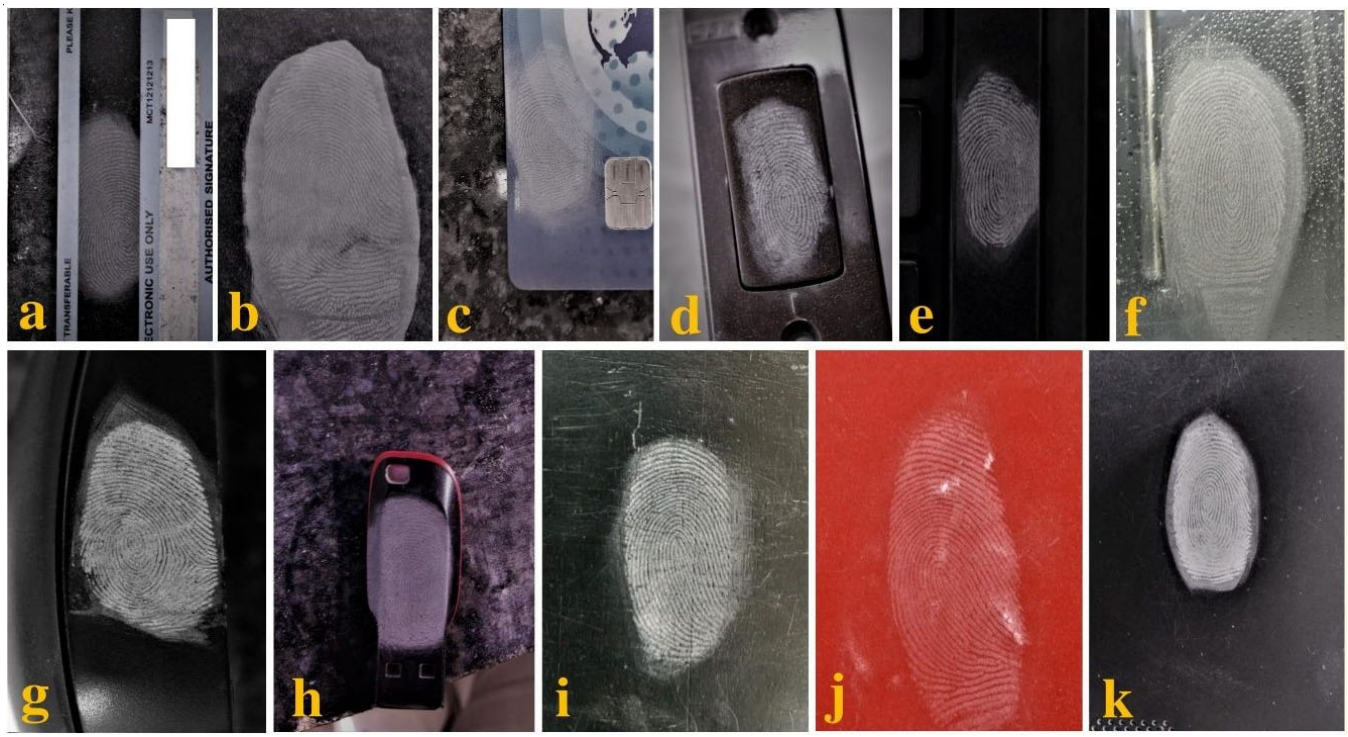

Fig. 3. Developed fingerprints on different plastic surfaces (a) magnetic strip of debit card (b) laminated cover of book (c) front side of debit card (d) electric switch (e) computer keyboard (f) transparent plastic bottle (g) computer mouse (h) pen drive (i) plastic container body (j) Plastic container cap (k) smartphone back cover

guard and aluminium foil since they have given Grade 4. Clear ridge details between 1/3 and 2/3 were found on fingerprints developed on smartphone back cover, plastic container body, computer keyboard, porcelain mug, steel plate, copper plate and the front side of debit card since they have given Grade 3. Less than 1/3 clear ridge details prints on currency coin, marble, computer mouse, matchbox, pen drive, rexine, tile and lock were of average quality thus they have assigned Grade 2. Prints developed on door latch and nitrile gloves showed some evidence of fingerprints, thus they have assigned Grade 1. Figs. 5-8 represents the quality of developed fingerprints on different classes of surfaces,

Results also showed that the greatest number of good quality fingerprints were developed on plastic surfaces (nine out of eleven) and glass surfaces (on all the three surfaces). Table-4 summarizes the different classes of surfaces with their respective developed fingerprints quality grade.

The present work showed the efficiency of commercially available talcum powder to decipher latent fingerprints on 28 non-porous and semi-porous surfaces commonly come into our contact in everyday life and can also be encountered in crimes. Despite the optimum efficiency of conventional powders for latent print development, non-conventional powders are recently being explored for their better efficiency in the decipherment of latent prints on different surfaces.

Sodhi & Kaur [10] and Kumari *et al.* [11] used synthetic food and festival colours (Gulal) on four surfaces *i.e.*, normal paper, aluminium foil, aluminium sheet and the top surface of

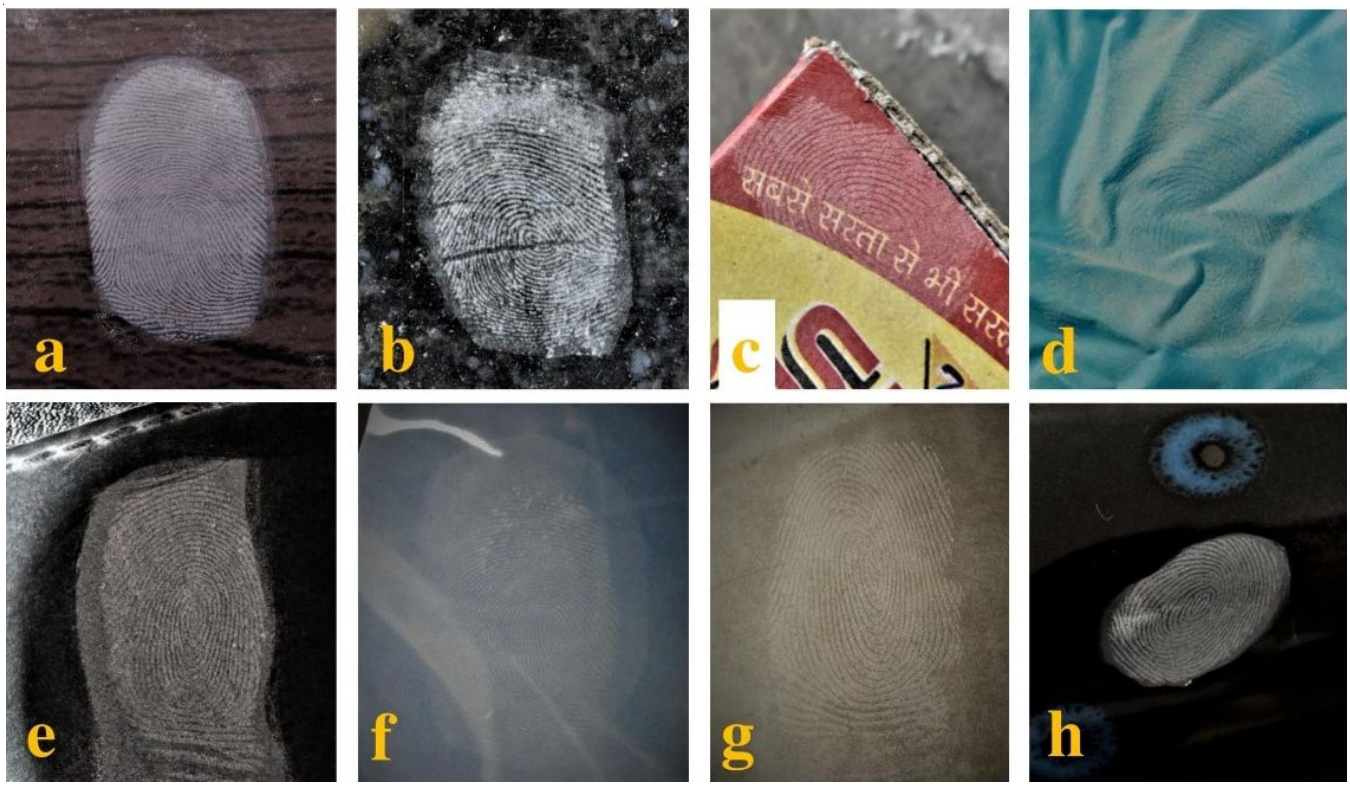

Fig. 4. Developed fingerprints on different metallic surfaces (a) gloss painted wood (b) marble (c) match box (d) rexine bag (e) tile (f) non-adhesive side of transparent tape (g) porcelain mug

TABLE-4
SUMMARIZED TABLE OF QUALITY SCORES OF DEVELOPED FINGERPRINTS ON DIFFERENT CLASSES OF SURFACES

			Score
1	Metal	Aluminium foil	4
2		Steel plate	3
3		Copper plate	3
4		Currency coin	2
5		Lock	2
6		Door latch	1
1	Glass	Eye glass	4
2		Smartphone touch screen	4
3		Smartphone touchscreen guard	4
1	Plastic	Laminated cover of book (transparent sheet)	4
2		Electric switch	4
3		Plastic container cap	4
4		Transparent plastic bottle	4
5		Magnetic strip of debit card	4
6		Front side of debit card	3
7		Smartphone back cover	3
8		Computer keyboard	3
9		Plastic container body	3
10		Computer mouse	2
11		Pen drive	2
1	Miscellaneous	Gloss painted wood	4
2		Porcelain mug	3
3		Marble	2
4		Match box	2
5		Tile	2
6		Nitrile gloves	1
7		Rexine polymer	2
8		Non-adhesive side of transparent tape	4

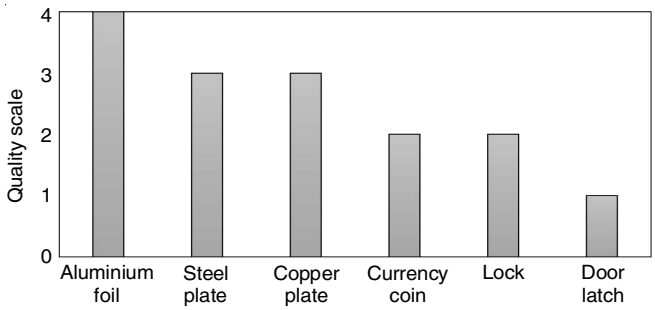

Fig. 5. Representation of the quality of developed fingerprints on different metallic surfaces

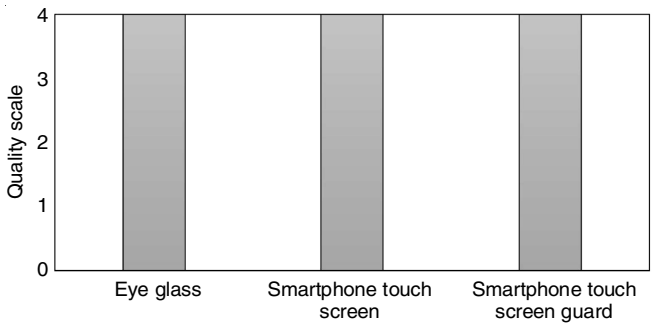

Fig. 6. Quality index of developed fingerprints on different glass surfaces

CD and observed that these powders give good results on aluminium foil and top side of CD. Garg *et al.* [5] applied turmeric powder on different types of paper (simple, bond and thermal), wooden surface (sun mica), different plastic sheets (transparency and normal), aluminium foil, top and writing

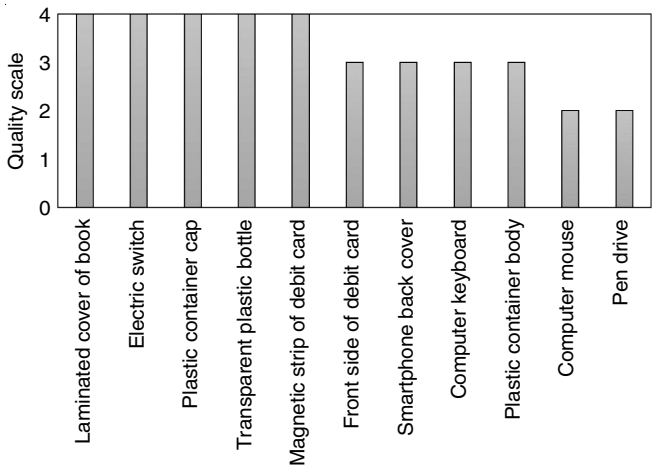

Fig. 7. Quality index of developed fingerprints on different plastic surfaces

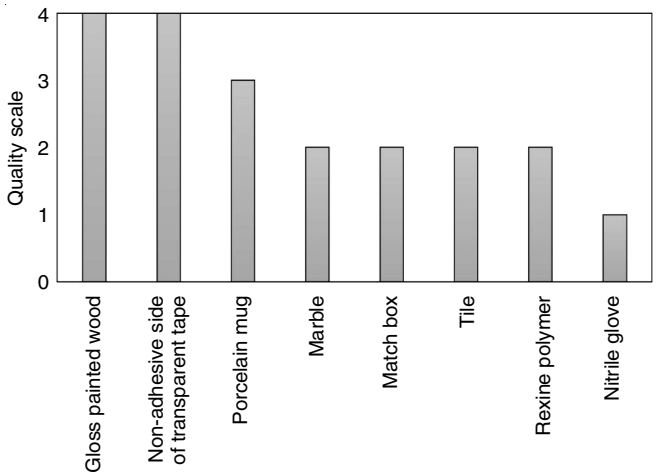

Fig. 8. Quality index of developed fingerprints on miscellaneous surfaces

surfaces of CD to develop latent fingerprints and found good result on all the surfaces except sun mica, thermal paper and painted sheet. Jossan *et al.* [12] used common household materials *i.e.*, baking powder, gram powder, cornflour, dry ginger powder, chocolate powder, refined wheat powder, custard powder, dry mango powder, ranipal and neel powder to develop latent prints on aluminium can and foil, glass and fibreglass, CD and transparency sheet and found that only four powders *i.e.* custard powder, baking powder, corn flour and ranipal showed satisfactory results. Dhunna *et al.* [20] also studied different household materials *i.e.* turmeric powder (*Curcuma longa*); cumin powder (*Cuminum cyminum*); garam masala (mixture of dried species and herbs), limestone, gram flour, coriander powder to develop latent fingerprints on aluminium foil and found good results except for coriander kitchen king and cumin powder.

Singh *et al.* [7] had used silica gel G powder to develop latent fingerprints on 19 different surfaces *i.e.*, plastic, glass, ordinary mirror and metallic surfaces, aluminium foil, carbon paper, matchbox, cardboard, glossy-painted wooden surfaces, the top and writable surface of CD and glazed coloured magazine paper. Except for carbon paper, cardboard and currency coin, good quality fingerprints were developed on the rest of the surfaces. In present study, similar good results were obtained on the matchbox, currency coin, transparent plastic bottle, spectacle, aluminium foil, gloss painted wood and laminated cover of book.

Badiye and Kapoor [2,3] used commercially available robin blue powder to develop latent prints on 24 porous, non-porous and semi-porous surfaces and observed that the applied powder gives a good visibility of prints on dark and transparent surfaces. Only keychain and rubber gloves proved to be poor substrates for fingerprint development by robin blue powder.

In present study, commercially available talcum powder was used to decipher latent fingerprints on 28 non-porous and semi-porous surfaces. All the surfaces were classified according to the nature of their material constituent *i.e.*, metal, glass, plastic and miscellaneous. Except for door latch and nitrile glove, good quality fingerprints were developed on all the surfaces by talcum powder. Best fingerprints were developed on all the glass surfaces (spectacle, smartphone touchscreen and smartphone touchscreen guard), six plastic surfaces (laminated cover of book, electric switch, plastic container cap, transparent plastic bottle, non-adhesive side of transparent tape, magnetic strip of debit card), one metal surface (aluminium foil) and one miscellaneous surface (gloss painted wood).

Conclusion

The present study has been carried out to explore the efficacy of commercially available talcum powder for the decipherment of latent fingerprint on commonly available non-porous surfaces at a preliminary level. This is a phase-I study, conducted in accordance with the IFRG guidelines. The study concluded that at the preliminary level talcum powder is very efficient for latent fingerprint development on various non-porous surfaces. The powder gave better results on dark and transparent surfaces with better contrast and clear ridge details. The prints on surfaces with comparatively light backgrounds can be better visualized by transferring the prints onto a dark surface with the help of a tape-lifting method. Latent prints were deciphered excellently on most of the glass and plastic surfaces in comparison to metal and miscellaneous surfaces. The powder used in the present study can be used in real-life case studies after it shows positive results in phase-II, phase-III and phase-IV experiments according to IFRG guidelines.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

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