

# Green Synthesis of Eco-Friendly Fingerprint Powders from Brewed Green and Black Tea Leaves

Ruchika Dwivedi<sup>1</sup>, Himanshu Kothari<sup>2</sup>, Geetika Saxena<sup>3</sup>, Vaishnavi Thakre<sup>4</sup>,  
Bhawana Jangir<sup>5</sup>

<sup>1</sup>Assistant Professor, Department of Forensic Science, JECRC University, Jaipur, India.

<sup>2</sup>Student, Department of Forensic Science, Gujarat University, Ahmedabad, India.

<sup>3</sup>Assistant Professor, Department of Forensic Science, JECRC University, Jaipur, India.

<sup>4</sup>Assistant Professor, Department of Forensic Science, JECRC University, Jaipur, India.

<sup>5</sup>Assistant Professor, Department of Chemistry, JECRC University, Jaipur, India.

Corresponding Author: Ruchika Dwivedi

DOI: <https://doi.org/10.52403/ijrr.20260210>

## ABSTRACT

The present study entitled “Green Synthesis of Eco-Friendly Fingerprint Powders from Brewed Green and Black Tea Leaves” was conducted in the department of Forensic Science, JECRC University, Jaipur. The objective of the study was to formulate a sustainable and greener fingerprint powder using brewed green and black tea leaves and to check the efficiency on various porous and non-porous surfaces. Samples of green tea and black tea were collected, cleaned, dried, grounded, sieved and stored. These powders were applied on various porous and non-porous surfaces and the developed latent fingerprints were photographed. The ridges were clearly visible even with the minute details making them suitable for comparing and analysing. A clarity score was denoted to each developed fingerprint using the standardized grading scale. Statistical test was applied to check whether the powders have equal efficiency with porous and non-porous surfaces. The purpose of this research is to investigate the feasibility and effectiveness of using these powders in forensic investigations, as well as to emphasize their contributions to sustainable and ecologically conscientious crime scene analysis. This research opens

doors for further exploration of unconventional, safe, and affordable fingerprint powder.

**Keywords:** Latent fingerprints, porous, non-porous, sustainable, efficiency, unconventional approach, Fingerprint, Green Fingerprint powder, Fingerprint Development.

## 1. INTRODUCTION

Fingerprints are the unique patterns of ridges and valleys found on the surface of a person's fingertips. These patterns start forming during the fetal development and are formed by friction on epidermal ridges and furrows, which appear on the pads of fingers and thumbs (Suryawanshi and Nalage,). These patterns remain largely unchanged throughout a person's life, making them a reliable means of identification. Fingerprints serve as an important physical evidence as each person's fingerprints are distinct and thus they are regarded as credible form of proof (Singh Sankhla, 2018). Many researchers have questioned the uniqueness of fingerprints with the passage of time, however they still remain a widely used method for identifying individuals, even identical twins (Low *et al.*, 2015).

Crime investigations using fingerprints has been documented for over a century, three types of fingerprints can be found at a crime scene- Plastic, Latent and Patent prints. (Datta, 2001). Plastic prints are three-dimensional impressions formed when a finger or palm touches or presses against a plastic material and creates impression of its frictional ridges. Patent fingerprints also known as visible prints are created when fingers are contaminated with a foreign material which makes the prints visible on a surface. Latent prints also known as invisible prints cannot be seen through unaided eye and can only be visible after proper development using specialized techniques. Latent fingerprints are considered more reliable than patent or plastic fingerprints as they are invisible to the naked eye and are formed using the natural oils and sweat from the skin (Aseri et al., 2022).

In the modern times crimes are becoming increasingly violent and complex, making investigations more challenging when it comes to apprehending the perpetrator. Latent fingerprints are regarded as one of the most critical evidence in identifying individuals who were present at the crime scene, helping to establish a connection to the offender (Park et al., 2018). In forensic investigations, the relationship between the criminal, the victim, and the crime scene can be firmly established through the detection of latent fingermarks (Hazarika and Russell, 2012).

Over the centuries a wide range of chemical and physical methods have been sought for the detection and development of latent fingerprints such as powder dusting, chemical fuming, metal deposition and fluorescent dyes (Champod, C., 2004). These traditional methods of latent fingerprint development are effective for various surfaces however they are not always effective in latent print detection, Thus scientists have attempted to improve the existing methods for the visualization of latent prints. (Garg et al., 2011)

The Powder dusting is the most researched and experimented technique as it is simple and popular method for developing latent print it's also one of the oldest techniques used by fingerprinting experts, it is most widely practiced as it does not require any sophisticated toolset and anybody can develop the prints using brushing and tapping. (Sodhi and Kaur, n.d.). It is highly effective method and provides clear fingerprint images when photographed which are recognized by the justice system (Yuan et al., 2020).

The fingerprint powder dusting method works on the principle that latent fingerprints consists of natural secretions such as sweat, oil and other residues, which adhere to surfaces when touched and when a fine powder is brushed on the latent print, the powder particles sticks to these residues making the invisible fingerprint visible (Said et al., 2021). The efficiency of developing fingerprints with a fingerprint powder is determined by several factors such as the particle size (fine or coarse), age of fingerprint, temperature, humidity, the contrast in colors between the surface and powder and the nature of surface (porous, semi porous and non-porous) (Vadivel et al., 2021)

In the present time a wide variety of powders are used for latent fingerprint development (Trapecar and Balazic, 2007). All the available powders can be categorized in four different categories: (i) regular powder; (ii) metallic powder; (iii) thermoplastic powder; and (iv) luminescent powder (V. et al., 2020). Regular powders used for fingerprint development include a resinous polymer such as starch, kaolin, and silica gel for adhesion, as well as a colorant made up of inorganic or organic compounds for better visualization of the latent prints (Sodhi and Kaur,). Metallic powders made up of meshed metal salts have been in use for considerable time. Some powder formulations also contain organic and inorganic derivatives that fluorescence upon exposure to ultraviolet or laser light. While these conventional powders have been in

use for generation, they also have cons-Time consuming, expensive, shorter shelf life, destructive, toxic in nature, limited contrast and low sensitivity

These fingerprint powders contain inorganic salt of heavy metals such as mercury, cadmium, titanium, lead, and manganese, which causes health hazards to the users (Said et al., 2021). The most commonly employed powders at the crime scenes are the black and white powder. The black powder consists of carbon and the white powder is made of titanium and they have also been linked to health risks (Champod, C., 2004). The white powder, titanium dioxide has been linked to cancer, according to research from international agency for research on cancer (Sodhi and Kaur, ) Thus using these powders can be a serious occupational hazard for forensic and law enforcement personnel who work with inorganic fingerprint powders (Van Netten et al., 1990)

With the numerous health concerns posed by the conventional fingerprint powders during occupational exposure a need for alternative fingerprint powder arises which is safer and non-toxic (Vadivel et al., 2021). However, an effective fingerprint powder must fulfill other criteria too such as the texture should be fine and smooth, the powder should be of good color contrast and it should have a long shelf life, should be cheap and easily available. This makes it difficult to make a powder that meets all of the above criteria however researchers have formulated numerous powders with the passage of time.

Researchers have explored non-conventional materials readily available in everyday life as potential alternatives for visualizing latent fingerprints such as talcum powder, turmeric powder (Garg et al., 2011) sandal wood powder (Suryawanshi and Nalage), cocoa powder, corn flour, custard powder (Rohatgi and Kapoor, 2014), medicinal and herbal powders from plants (Nugroho et al., 2023) and other commonly available powders (Vadivel et al., 2021). These

powders were selected based on factors such as inexpensive, easily available, non-toxic and as a sustainable alternative to conventional fingerprint powders.

The recent developments by researchers have been on a greener approach towards the fingerprint powders, researchers have been using plant products and waste to develop fingerprint powders. (Sari et al., 2019) explored gambir powder, derived from the dried extract of *Uncaria gambir Roxburgh* plants, as a natural and cost-effective alternative for fingerprint visualization. Native to India, Sri Lanka, Indonesia, and Malaysia, gambir is traditionally used as a medicinal material. Studies found that gambir powder works effectively for visualizing latent fingerprints on dry, non-porous surfaces. Coarse gambir powder performs better on glass slides and transparent plastics, while finer particles are more effective on plastic cups, compact discs, and aluminum foils. In another study by (Passos et al., 2021) algal biomasses were used to visualize latent fingerprints. (Thakur and Garg, 2016) used fuller earth as an alternative for fingerprint powder, this method produced clear images of developed fingermarks on various surfaces.

In order to discover new fingerprint powders that are sustainable, efficient and eco-friendly, researchers used natural waste materials that is available in abundance to develop fingerprint powders such as rice husk, which is the waste product after rice milling (Rajan et al., 2019) or the use of eggshells and seashell wastes (Said et al., 2021) these powders produced clear images of developed fingermarks on the majority of tested substrates.

The present study aimed to develop a new fingerprint powder which is non-toxic, inexpensive, sustainable and naturally originated. One such natural waste available in abundance is used tea leaves. The tea plant, *Camellia sinensis*, is a perennial evergreen shrub in the *Theaceae* family, cultivated for its leaves used to produce various teas. Thriving in tropical and subtropical climates, it plays a key role in

the global tea industry. Rich in antioxidants like polyphenols and catechins, tea offers potential health benefits, including better heart health, reduced cancer risk, and improved cognitive function. Green tea, in particular, is praised for its ability to boost metabolism and support weight management. For the present study we have used the *csinensis var. assamica* variety of the tea plant species. It is commonly known as the Assam tea plant and is primarily grown in the Assam region of India, as well as other tropical areas. This variety is characterized by its large leaves and thrives in warm, humid climates at lower altitudes. Tea can be broadly classified into four types on the basis of manufacturing process; black tea, green tea, oolong tea and instant tea (Baruah, P., 2015) In this study we use black and green tea only, black tea is produced by the process of withering, rolling, oxidization and drying. Green tea production involves only the processes of rolling and drying. The oxidation process turns the leaves darker, thus producing black tea and the green tea is non oxidized.(Engelhardt, 2020)

The leaf extract of tea contains specific polyphenols and an enzyme, polyphenol oxidase. As soon as the leaves are chopped, the enzyme is activated and the polyphenols are oxidized (Weisburger, 1997). The primary objective of this research is to introduce tea leaves powder as a cutting edge and ecologically stable solution for elevating the clarity of fingerprints and to explore the effective waste management of tea leaves as a sustainable and eco-friendly alternative for enhancing latent fingerprints in forensic science. The study aims to evaluate its practicality, effectiveness, and overall feasibility as a green solution for fingerprint visualization.

## 2. LITERATURE REVIEW

Garg et al., 2011, studied the properties of turmeric powder, a common ingredient in Indian food and used it to decipher latent fingerprints on different surfaces such as thermal paper, aluminum foil, wood surface,

and many other. The experimental results were very clear and evident on most of the surfaces. This fingerprint powdering method was cost-effective, easily available and simple in procedure.

Madkour et al., 2017 conducted a study to determine the optimal method for latent fingerprints development on non-porous surfaces submerged in aquatic environment at different time intervals. Different metallic, glass and plastic surfaces were selected for the study and they were submerged in two different aquatic environment, fresh water and sea water. These surfaces were recovered at different time intervals of 1,2 and 10 days. After recovery the surfaces were dried and were processed by black powder, small particle reagent and cyanoacrylate fuming and the fingerprints were examined. These developed latent prints found to have the most visibility after submersion in fresh and sea water for 1, 2 and 10 days. The visibility of prints developed showed significant decline after 10 days of submersion. The study analysed two main factors, the nature of aquatic environment and the length of submerged time.

Nugroho et al., 2023 explored the use of natural powders derived from four medicinal plants- *Zingiber montanum*, *Solanum Indicum L.*, *Rhinacanthus nasutus*, and *Euphorbia tirucalli* as a safer approach in fingerprint development. These natural substances pose fewer health risks and exhibit florescence properties enhancing fingerprint visibility on various surfaces. The powders were also tested for the presence cyanide which is hazardous to human health. The powders were analyzed using UV light, fluorescence spectrophotometry, FIB-SEM, and FTIR, showing effective performance and reduced toxicity compared to traditional fingerprinting methods.

Passos et al., 2021 evaluated the potential of algal biomass from *Chlorella sp.*, *Desmarestia anceps*, *Laurencia dendroidea*, *Lessonia searlesiana*, and *Spirulina sp.* as alternatives to toxic

commercial fingerprint developers. The algae were rich in biochemical compounds, with carboxylic acids ranging from 1.52% (*D. anceps*) to 50.94% (*Chlorella* sp.), and alcohols from 28.39% (*Chlorella* sp.) to 83.74% (*L. searlesiana*). Particle sizes varied between 42.18 and 140.00  $\mu\text{m}$ . Chemical analysis revealed hydroxyl, carbonyl, and carbon-nitrogen group vibrations, with a significant composition of metals like potassium (9.63–51.83%), calcium (5.98–40.62%), and iron (0.06–12.85%), which are non-toxic. Among the biomasses, *Spirulina* sp. demonstrated superior performance in latent fingerprint development, providing clear and satisfactory results.

**Rai et al., 2024** explored the use of gram flour powder, prepared by roasting and grinding to develop latent fingerprints. The powder was used on diverse surfaces, treated, rough and wet surfaces. It performed well on contrasting surfaces but showed low adherence on non-porous surface. Due to its non-toxic nature and low cost, gram flour powder shows promise as an eco-friendly and affordable alternative for large-scale fingerprint visualization.

**Rai et al., 2024.** evaluated the use of Ashwagandha powder (*Withania somnifera*), a non-toxic and eco-friendly herbal substance, for fingerprint detection on porous and non-porous surfaces, including aluminum foil, plywood, rubber, and leather. The powder produced high-contrast fingerprints on most surfaces, with aluminum foil and plywood yielding the best clarity. Although results on leather were less effective, the method proved to be an eco-friendly and practical technique for crime scene investigations.

**Rajeshkumar, S. and Vikraman, K.S., 2021** developed fingerprint powder using strawberry fruit, they dried the fruit under room temperature for about a month and then fine grained them using nanotechnology. The formed powder was used to develop fingerprints on various surfaces. The prints developed were well

defined and the powder was also found useful for aged latent fingerprints.

**Rajan et al., 2019** the challenges in fingerprint development and identification on surfaces that are reflective, multicoloured and patterned in nature, and to find a solution to this problem they synthesized fluorescent silica nanoparticles (SNPs) from rice husk using thermochemical treatment and incorporated them with natural dyes extracted from turmeric, blue pea flower, purple cabbage and dried red chillies. Different techniques such as field emission scanning electron microscopy, Fourier-transform infrared spectroscopy, X-ray diffraction analysis and forensic alternative light source were used to record the photoluminescence of the powders. They found that fluorescent silica powder synthesized from rice husk and curcumin dye extract exhibited good photoluminescence and provides sufficient contrast for the fingerprint analysis on difficult and challenging surfaces and the spherical mono-dispersed nanoparticles enhanced the clarity and selectivity of the powder.

**Rohatgi, R. and Kapoor, A.K., 2014** explored the use of common, non-toxic, and inexpensive household kitchen products such as cocoa powder, custard powder, corn flour, baking soda, black salt, and turmeric powder for developing latent fingerprints. These alternatives were used to minimize the health hazards posed by conventional fingerprint powders and are readily available, making them practical for situations where traditional powders are scarce or unavailable. The method is simple, cost-effective, providing a novel and innovative approach to forensic fingerprinting.

**Sari et al., 2020** developed purple sweet potato powder as a visualization method of latent fingerprints. The powder was tested on five surfaces, aluminum foil, transparent plastic, plastic cups, CDs, and white paper. The research was carried out in the INAFIS regional police laboratory, different sizes of powder ranging from 60-200 mesh were

used in the process. The study found that powder sizes of 100 and 200 mesh produced the best results, forming a brownish-purple contrast that made fingerprints clearly visible.

**Sari et al., 2019** proposed the use of gambir powder, a traditional herb extracted from the leaves and twigs of *Uncaria Gambir Roxburgh* plants, which are native to Sri Lanka, Indonesia and Malaysia. The study also highlights the harmful health risks of traditional fingerprint powders, which often contain toxic substances like titanium dioxide and lead and It proposes gambir plant powder as a safer and more environmentally friendly alternative. The study shows that gambir powder is capable of visualizing fingerprints on dry, non-porous surfaces however the study reveals that the quality of fingerprints developed are highly influenced by the particle size of gambir powder as well as the type of surface used. The coarse gambir powder (0.250mm) was found suitable for surfaces such as glass slides and transparent plastics, while finer particles of 0.125mm showed better results for plastic cups, compact discs and aluminum foils.

**Suryawanshi and Nalage,2021** presented the use of sandal wood powder as a new method for developing fingerprints. The powder was characterized as less expensive, non-toxic and easily available. The powder was used to develop fingerprints on different surfaces including metal surfaces, clay surfaces, non-porous surfaces, and computer/ mobile surfaces. The results were very clear for majority of the surfaces however fingerprints could not be developed on skin and cotton surfaces.

**Yadav et al., 2020** in search of a non-toxic and a common compound proposed the possibility of using spinach powder to visualize latent finger prints. The spinach powder was prepared using the process of blanching and dehydration to enhance the retention period of pigments. The powder was used for latent fingerprint detection on various surfaces, including wood, floor,

rubber, glass, plastic, CD, and foil. Compared to turmeric and the chemical dye Eosin yellow, spinach powder demonstrated superior results. The method is safe, cost-effective, and environmentally friendly, offering a viable alternative for fingerprint visualization across diverse surfaces.

### 3. MATERIALS & METHODS

The present study entitled “**Green Synthesis of Eco-Friendly Fingerprint Powders from Brewed Green and Black Tea Leaves**” was conducted at the department of forensic science JECRC University during the period of November-December 2024.

#### 3.1 Sample Collection

For the purpose of sample collection, we selected the *Camellia sinensis var. assamica* variety of tea leaves. The black tea was brewed to make milk tea, no additional additives other than milk and sugar were added. The tea was strained collecting the tea leaves in the strainer. These used tea leaves were collected. In case of green tea, they were brewed only in water and strained to collect the used tea leaves. A total of about 150 grams of black tea and 100 grams of green tea were collected from 6-7 brewing sessions over a period of 3 days. Materials required: tea samples (black and green), electric grinder, mortar and pestle, wooden trays, air tight containers, Ostrich hair brush, paper towels, petri dishes, sieve, various porous and non- porous surfaces

#### 3.2 Pre-preparation

##### 3.2.1 Cleaning

After the collection of used tea leaves from all the brewing sessions, they were mixed together forming two batches one of black tea and other of green tea, both the samples were rinsed under cold running water for 4-5 times to remove residual flavours and impurities.

These samples were left in strainer for about 30 mins and then squeezed to remove the excess water and collect the solid residue.

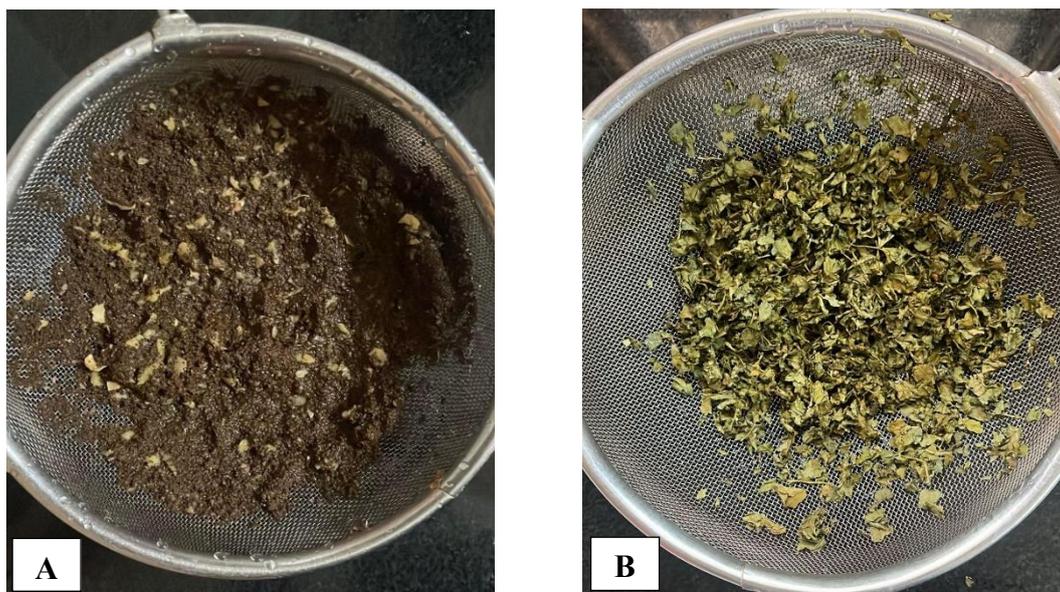


Figure 1- The Process of Straining Water after Cleaning. (A) Black Tea (B) Green Tea

### 3.2.2. Drying

The squeezed leaves are spread on a clean tray layered with paper towel to absorb the moisture. The leaves are dried thoroughly under sunlight for about 72 hours such that no moisture is left in them (R et al., 2024). The temperature ranged between 28-32 °C

with humidity of about 75% The tray was placed in direct sunlight during the day and taken indoors during the night time and kept under a fan to speed the process of drying. The leaves were stirred occasionally, and this process continued for three to four days until the leaves felt crispy and brittle.

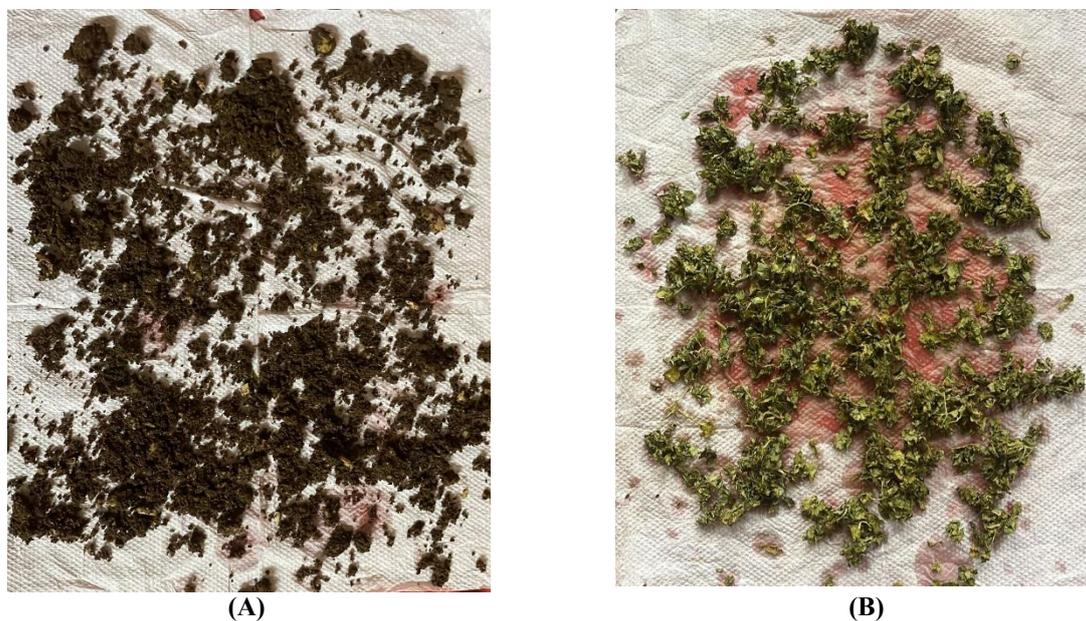


Figure 2 - The Process of Drying the Sample (A) Black Tea (B) Green Tea

## 3.3 Powder Preparation

### 3.3.1 Grinding

After the sufficient duration of air drying, the leaves are checked whether they are completely moisture free and brittle. The leaves were first manually crushed to obtain

a grainy powder (Yadav et al., 2020) then the leaves were crushed using a mortar and pestle to develop a more finer coarse powder. Now this coarse powder was divided in batches and placed in an electric grinder and the grinding process of each

batch was carried out in small bursts to avoid overheating of the appliance. This process of grinding was repeated for at least five times to achieve the required amount of fine powder (Said et al., 2021). Each sample was grounded to get a fine powder to the

level and texture of talcum powder however no particle size was measured. (Garg et al., 2011). The powder was directly transferred into a fine mesh sieve and was left for some time to cool down



Figure 3 - The Particle Size of Powder before Grinding (A)Black Tea (B)Green Tea

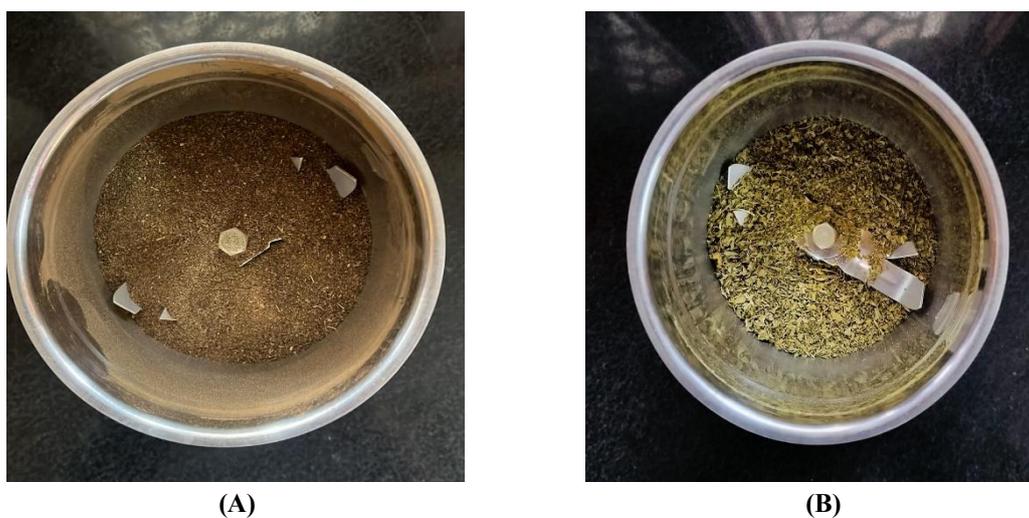


Figure 4 - The Particle Size of Powder after Grinding (A)Black Tea (B) Green Tea

### 3.3.2 Sifting

The finely grounded powder was passed through a fine wire mesh to separate finer powder from coarse particles; these larger particles were grounded again to achieve a uniform texture. The finer powder that was sieved through the wire mesh was again

sieved through a muslin cloth to get a finer texture and smooth appearance and the powder was collected onto a tray and left to cool down properly in room temperature. Finer powders would be capable of displaying greater detail than coarse powders.



Figure 5 - The Powders after Sieving through a Wire Mesh (A)Black Tea (B) Green Tea

### 3.3.3 Storage

The powders are stored in plastic air tight containers, the containers are labelled as black tea powder, and green tea powder with the date of manufacturing that is 10<sup>th</sup> November 2024. The containers are kept in a cool, dry and dark place away from direct sunlight and moisture which can degrade the quality of the powder. The powders are kept in air tight containers as it can absorb moisture from the surroundings if kept in open and degrade, thus causing problem in development of latent fingerprints (Thakur and Garg, 2016)

### 3.4 Development of Fingerprints

The experiments were carried out in the months of December/January when the temperature varied from 8-18 °C and the relative humidity between 60-75% this research was carried out in Jaipur, Rajasthan. Powder dusting method was used to detect and develop latent fingerprints for the research; a small quantity of powder was placed into a small bowl. Subsequently, the surface designated for the experiment was meticulously cleaned using a dust cloth to ensure a clean and smooth working environment(Paliwal et al., 2023). The test latent prints which included sebum and sweat from face and forehead region were collected from donors on various surfaces(Yadav et al., 2020) these surfaces

included both porous and non-porous surfaces two sets of fingerprints were taken on each surface. Once the fingerprints were taken they were left in room temperature for about 2 hours(Sari et al., 2019) An ostrich hair brush was then carefully dipped into the black tea powder and the green tea powder separately, with only the tips of the bristles being lightly coated with the powder, Excess powder was removed by tapping the brush gently, the pressure applied through the brush was carefully monitored as excessive pressure could cause smudging in the print. The brush was swept lightly where latent fingerprint was marked. Due to the adhesive property of the powder, the powder attached to the residual remains of the fingerprint(Rai et al., 2024). Upon completing the dusting process, the excess powder on the surfaces were gently blown off, and the developed fingerprint was inspected for clarity and quality. The developed fingerprint was photographed for the analysis of fingerprint and identification. A clarity score was denoted to each print on the basis of a Fingerprint grading scale system as described in table according to the fingerprint grading system. The black tea and green tea powders serve as a reliable alternative for conventional powders and helped in clear visualisation of latent prints on various surfaces.

**Table 1- Fingerprint Grading Scale (Said et al., 2021)**

Clarity (%)	Score	Description	Characteristics
0-20	Poor	The outline of the developed print is fully smudged or has no evidence of print.	
20-40	Fair	Ridges developed cannot lead to the identification	
40-60	Good	Part of the developed fingerprint is majorly smudged or not developed properly; although ridge details are present but analysis cannot be performed.	
60-80	Very Good	Prints are developed properly, but a minor part of the print is smudged; analysis can be performed.	
80-100	Excellent	Clear ridge details appeared and identification can be done properly	

**Table 2 – Clarity score of Developed Fingerprint using Black Tea Powder**

Below figures 1-20 shows latent fingerprint developed using black tea powder on various porous and non-porous surfaces



**Fig. 1: Paper Clarity Score 60-80%**



**Fig. 2: Sun board Clarity Score 80-100%**



**Fig. 3: Fiber glass Clarity Score 60-80%**



**Fig. 4: Ply board Clarity Score 60-80%**



**Fig. 5: Card board Clarity Score 40-60%**



**Fig. 6: Aluminum Foil Clarity Score 40-60%**



**Fig. 7: Stainless Steel Clarity Score 60-80%**



**Fig. 8: Rubber Clarity Score 80-100%**

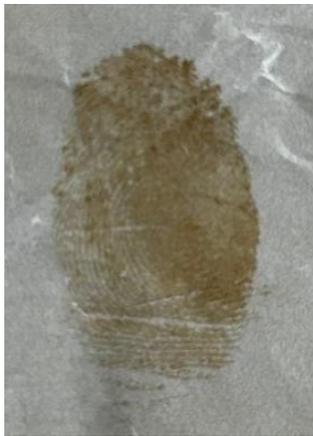


Fig. 9: Thermal paper Clarity Score 20-40%



Fig. 10: Ceramic Clarity Score 80-100%



Fig. 11: Leather Clarity Score 20-40%



Fig. 12: Mirror Clarity Score 60-80%



Fig. 13: Plastic Clarity Score 60-80%



Fig. 14: Bakelite Clarity Score 80-100%



Fig. 15: Mobile Screen Clarity Score 80-100%



Fig. 16: Varnished Wood Clarity Score 60-80%



Fig. 17: Wall Clarity Score 80-100%



Fig. 18: Tile Clarity Score 20-40%



Fig. 19: Wallpaper Clarity Score 0-20%



Fig. 20: Cloth Clarity Score 0-20%

**Table 3 – Clarity score of Developed Fingerprint using Green Tea Powder**  
Below figures 1-20 shows latent fingerprint developed using green tea powder on various porous surfaces



Fig. 1: Paper Clarity Score 60-80



Fig. 2: Sun board Clarity Score 60-80%



Fig. 3: Fiber glass Clarity Score 40-60%



Fig. 4: Ply board Clarity Score 20-40%



**Fig. 5: Card board Clarity Score 0-20%**



**Fig. 6: Aluminum Foil Clarity Score 20-40%**



**Fig. 7: Stainless Steel Clarity Score 60-80%**



**Fig. 8: Rubber Clarity Score 60-80%**



**Fig. 9: Thermal paper Clarity Score 40-60%**



**Fig. 10: Ceramic Clarity Score 60-80%**



**Fig. 11: Leather Clarity Score 0-20%**



**Fig. 12: Mirror Clarity Score 40-60%**



**Fig. 13: Plastic Clarity Score 60-80%**



**Fig. 14: Bakelite Clarity Score 60-80%**



**Fig. 15: Mobile Screen Clarity Score 80-100%**



**Fig. 16: Varnished Wood Clarity Score 40-60%**



**Fig. 17: Wall Clarity Score 40-60%**



**Fig. 18: Tile Clarity Score 20-40%**



**Fig. 19: Wallpaper Clarity Score 0-20%**



**Fig. 20: Cloth Clarity Score 0-20%**

### Statistical Analysis

To further test the efficiency of green and black tea powder on both porous and non-porous surfaces and to see whether their efficacy on both the surfaces is equal or not we use the Wilcoxon statistics (Said et al., 2021) test on Statistical package for social sciences (SPSS).

### RESULT

After successful development of fingerprints on various porous and nonporous surfaces using both the black tea and green tea powder, A clarity score was assigned to each of the developed prints. The general idea was to use a standardized system to assess the quality and clarity of fingerprints with higher grades indicating better quality and clearer ridge characteristics. Upon physical appearance the best prints with about 80-100% clarity scores were developed on ceramic, wall, tiles, rubber, mobile screens, etc. and the least clarity score 0-20% was seen for cloth, fabric and wall paper.

To carry out the test two hypothesis were formulated accordingly-

### Null hypothesis ( $H_0$ )

The null hypothesis establishes that there is no significant relationship between the efficiency of green and black tea powder on porous and non-porous surfaces and their efficacy on both the surfaces are equal.

### Alternative hypothesis ( $H_a$ )

The alternative hypothesis establishes that there is significant relationship between the efficiency of green and black tea powder on porous and non-porous surfaces and their efficacy on both the surfaces would not be equal which means one of the powders might be more suitable on efficacy over other powder on comparison.

Hence the hypotheses to be tested would be:

**$H_0: PA=PB$**

**$H_A: PA \neq PB$**

Where PA is Powder A (Black Tea Powder) and PB is Powder B (Green Tea Powder)

To make the tests easier to interpret a second clarity scoring was done according to the table 4. (Said et al., 2021)

Table 4- Clarity grading scale

Clarity Score	Description	Characteristics
1	Poor	The outline of the developed print is fully smudged or has no evidence of print.
2	Fair	Ridges developed cannot lead to the identification
3	Good	Part of the developed fingerprint is majorly smudged or not developed properly; although ridge details are present but analysis cannot be performed.
4	Very Good	Prints are developed properly, but a minor part of the print is smudged; analysis can be performed.
5	Excellent	Clear ridge details appeared and identification can be done properly

All the porous surfaces were marked 1 and the non-porous surfaces were marked 2. And the following table was formulated accordingly.

Table 5- Formulated test table

Surface Type	Black Tea	Green Tea
1	4	4
1	5	4
1	4	2
1	3	1
1	5	4
1	2	3
1	2	1
1	5	3
1	1	1
1	1	1
2	4	3
2	3	2
2	4	4
2	5	4
2	4	3
2	4	4
2	5	4
2	5	5
2	4	3
2	2	2

**Table 6- Null hypothesis testing for porous surfaces**

Porous				
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Powder_A_Green_Tea and Powder_B_Black_Tea equals 0.	Related-Samples Wilcoxon Signed Rank Test	.046	Reject the null hypothesis.
Asymptotic significances are displayed. The significance level is .05.				

**Table 7- Null hypothesis testing for non-porous surfaces**

Non porous				
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Powder_A_Green_Tea and Powder_B_Black_Tea equals 0.	Related-Samples Wilcoxon Signed Rank Test	.014	Reject the null hypothesis.
Asymptotic significances are displayed. The significance level is .05.				

The Wilcoxon Signed-Rank Test was applied, which is a non-parametric test to compare two related groups. The p-value for porous surface obtained was 0.046 and for no porous surface it was found as 0.014. Since the p-value for both the surface for both the powders is less than the standard

significance level (0.05), hence we tend to reject the null hypothesis. When the null hypotheses are rejected, the alternate hypotheses are automatically accepted which means that there is a statistically significant difference between the performance of Powder A and Powder B.

**Table 8- Alternate hypothesis testing**

Surface Type	Surface Type	Surface Type	Powder A Green Tea	Powder B Black Tea
Porus	Median	1.00	2.5000	3.5000
Non_Porus	Median	2.00	3.5000	4.0000

The statistical data obtained from Wilcoxon test using SPSS tool establishes a lot about the powders and their efficiency and efficacy in regards to their median on Fingerprint developed using newly synthesized black and green tea powder on porous and non-porous surfaces. The statistics obtained concluded that both the black and green tea powders showed different levels of efficiency on porous and non-porous surfaces. On comparison to the efficacy of both the powders on both the surface, it was found that the efficacy was slightly greater on non-porous surfaces than on porous surfaces. As the table shows that the median for black tea powder was found

greater for both porous and non-porous surface which establishes that out of the two formulated powders black tea powder was more efficient than green tea powder in developing latent fingerprints. The use of statistics makes the study more thorough and useful for further researchers and scientists who want to research on similar topics.

## DISCUSSION

The statistical data obtained from Wilcoxon test using SPSS tool establishes a lot about the powders and their efficiency and efficacy in regards to their median on Fingerprint developed using newly

synthesized black and green tea powder on porous and non-porous surfaces. The statistics obtained concluded that both the black and green tea powders showed different levels of efficiency on porous and non-porous surfaces. On comparison to the efficacy of both the powders on both the surface, it was found that the efficacy was slightly greater on non-porous surfaces than on porous surfaces. As the table shows that the median for black tea powder was found greater for both porous and non-porous surface which establishes that out of the two formulated powders black tea powder was more efficient than green tea powder in developing latent fingerprints. The use of statistics makes the study more thorough and useful for further researchers and scientists who wants to research on similar topic

## CONCLUSION

The present study entitled “Green Synthesis of Eco-Friendly Fingerprint Powders from Brewed Green and Black Tea Leaves” was conducted in the department of Forensic Science, JECRC University, Jaipur. The samples were collected, cleaned, dried, grounded, sieved and the powder was stored in air tight containers. The powders were applied on various porous and non-porous surfaces and the developed fingerprints were photographed. The developed fingerprints were analysed and a clarity score was assigned to each fingerprint according to the standardized grading scale. The Statistical tests were applied on the clarity scale to check whether both the powders show equal efficiency with the surfaces. Both the individual powders show better efficacy with nonporous surfaces than with porous surfaces. However black tea powder is more efficient than green tea powder on both the surfaces

This research has revealed the exceptional potential of Tea leaves powder, which can be used to improve fingerprint development in environmentally friendly and sustainable ways. The strategy of employing brewed tea leaves powder as a fingerprint powder, has

demonstrated tremendous promise in the latent fingerprint development. This research suggests that the effectiveness of naturally available resources on various surfaces needs to be evaluated. The scope for further enhancement on fingerprint powders using natural sources includes improving material selection, developing better formulation, exploring new application techniques, ensuring compatibility with surface. One of the main limitations of using tea powder as a fingerprint powder is its inconsistent particle size and texture, which affects the clarity and visibility of the developed fingerprints. A potential, sustainable, and economically advantageous resource for fingerprint enhancement is Tea leaves powder.

### Declaration by Authors

**Acknowledgement:** None

**Source of Funding:** None

**Conflict of Interest:** No conflicts of interest declared.

## REFERENCES

1. Aseri, V., Nagar, V., Godara, V., Pandit, P.P., Chopade, R.L., Verma, R., Sharma, A., Parihar, K., Awasthi, K.K. and Singh, A., 2022. A comparative study on scanned fingerprint after applying lubricants and without scanned fingerprint on porous surface;(white paper). *Materials Today: Proceedings*, 69, pp.1515-1531.
2. Badiye, A., Kapoor, N., 2015. Efficacy of Robin® powder blue for latent fingerprint development on various surfaces. *Egyptian Journal of Forensic Sciences* 5, 166–173. <https://doi.org/10.1016/j.ejfs.2015.01.001>
3. Crime Investigating Technique to Development of Invisible Fingerprints on Surfaces using Rock Phosphate Powder. *Int J Forens Sci* 2018, 3(1): 000133., 2018.
4. Champod, C., 2004. *Fingerprints and Other Ridge Skin Impressions*. CRC press google scholar, 2, pp.355-389.
5. Errington, B., Lawson, G., Lewis, S.W., Smith, G.D., 2016. Micronised Egyptian blue pigment: A novel near-infrared luminescent fingerprint dusting powder. *Dyes and Pigments* 132, 310–315.

- <https://doi.org/10.1016/j.dyepig.2016.05.008>
6. Garg, R.K., Kumari, H., Kaur, R., 2011. A new technique for visualization of latent fingerprints on various surfaces using powder from turmeric: A rhizomatous herbaceous plant (*Curcuma longa*). *Egyptian Journal of Forensic Sciences* 1, 53–57. <https://doi.org/10.1016/j.ejfs.2011.04.011>
  7. Hazarika, P., Russell, D.A., 2012. Advances in Fingerprint Analysis. *Angew Chem Int Ed* 51, 3524–3531. <https://doi.org/10.1002/anie.201104313>
  8. Kulikov, O.V., Peranathan, S., Novak, B.M., 2024. Electrospinning of alkyne polycarbodiimide fibers. *Results in Chemistry* 7, 101356. <https://doi.org/10.1016/j.rechem.2024.101356>
  9. Lian, J., Meng, F., Wang, W., Zhang, Z., 2020. Recent Trends in Fluorescent Organic Materials for Latent Fingerprint Imaging. *Front. Chem.* 8, 594864. <https://doi.org/10.3389/fchem.2020.594864>
  10. Low, W.Z., Khoo, B.E., Aziz, Z.B.A., Low, L.W., Teng, T.T., Abdullah, A.F.L.B., 2015. Application of acid-modified *Imperata cylindrica* powder for latent fingerprint development. *Science & Justice* 55, 347–354. <https://doi.org/10.1016/j.scijus.2015.04.008>
  11. Lee, H.C. and Gaensslen, R.E., 2001. Methods of latent fingerprint development. *Advances in fingerprint technology*, 2(105-176), p.10.
  12. Madkour, S., Abeer Sheta, El Dine, F.B., Elwakeel, Y., AbdAllah, N., 2017. Development of latent fingerprints on non-porous surfaces recovered from fresh and sea water. *Egypt J Forensic Sci* 7, 3. <https://doi.org/10.1186/s41935-017-0008-8>
  13. Nugroho, D., Chanthai, S., Oh, W.-C., Benchawattananon, R., 2023. Fluorophores - rich natural powder from selected medicinal plants for detection latent fingerprints and cyanide. *Science Progress* 106, 00368504231156217. <https://doi.org/10.1177/00368504231156217>
  14. Paliwal, A., Pathak, G., Chandrakar, D.T., Biswas, A., Student, P.G., Student, P.G., 2023. Development of Latent Fingerprints on Non-Porous Surfaces using Walnut Shell Fly Ash 11.
  15. Park, J.Y., Park, S.J., Kwak, M., Yang, H.K., 2018. Rapid visualization of latent fingerprints with Eu-doped La<sub>2</sub>Ti<sub>2</sub>O<sub>7</sub>. *Journal of Luminescence* 201, 275–283. <https://doi.org/10.1016/j.jlumin.2018.04.012>
  16. Passos, L.F., Berneira, L.M., Poletti, T., Mariotti, K.D.C., Carreño, N.L.V., Hartwig, C.A., Pereira, C.M.P., 2021. Evaluation and characterization of algal biomass applied to the development of fingermarks on glass surfaces. *Australian Journal of Forensic Sciences* 53, 337–346. <https://doi.org/10.1080/00450618.2020.1715478>
  17. Pattarith, K., Chanthai, S., Benchawattananon, R., 2021. Fluorescent Labeling of Silica Gel Powder using Zingiber Montanum Extract for a Bright Latent Fingerprint Detection under UV Light. *Orient. J. Chem* 37, 541–546. <https://doi.org/10.13005/ojc/370304>
  18. R, I., Gupta, P., S, M., R, D., 2024. A study on development of fingerprint powders using natural sources for latent fingerprint visualization on non-porous surfaces. *Int. J. Forensic Med.* 6, 49–52. <https://doi.org/10.33545/27074447.2024.v6.i1a.80>
  19. Rai, A.R., Sharma, V., Jain, D., Kaur, A., Agrawal, M., Kanoujiya, V., Nagar, V., Kumari, P., Awasthi, K.K., Verma, R.K., Sankhla, M.S., n.d. Exploring the Forensic Potential of Ashwagandha (*Withania somnifera*) Powder: A Novel Approach for Enhancing Latent Fingerprint Development.
  20. Rai, A.R., Sharma, V., Nagar, V., Kanoujiya, V., Aseri, V., Sharma, A., Jain, D., Singh, A., Gautam, A., Awasthi, K.K., Sankhla, M.S., 2024. Low-cost alternative approach to developing latent fingerprints using roasted gram flour (sattu powder). *Problems of Forensic Sciences* 143–154. <https://doi.org/10.4467/12307483PFS.23.009.19058>
  21. Rajan, R., Zakaria, Y., Shamsuddin, S., Hassan, N.F.N., 2020. Green Chemistry Synthesis of Nanostructured Zinc Oxide Powder Using *Azadirachta indica* Extract for Latent Fingerprint Development.
  22. Rajan, R., Zakaria, Y., Shamsuddin, S., Nik Hassan, N.F., 2019. Fluorescent variant of silica nanoparticle powder synthesised from rice husk for latent fingerprint development. *Egypt J Forensic Sci* 9, 50. <https://doi.org/10.1186/s41935-019-0155-1>

23. Rohatgi, R., Kapoor, A.K., 2014. New Visualizing Agents for Developing Latent Fingerprints on Various Porous and Non-Porous Surfaces Using Different Household Food Items. *AJSAT* 3, 33–38. <https://doi.org/10.51983/ajsat-2014.3.2.792>
24. Said, N.F.N., Anuar, S.N., Zakaria, Y., Rajan, R., Mohd, N., Hassan, N.F.N., 2021. Recycling Potential of Natural Waste Products in the Development of Fingerprint Powders for Forensic Application.
25. Saran, V., Kesharwani, L., Gupta, A.K., Mishra, M.K., 2015. COMPARATIVE STUDY OF DIFFERENT NATURAL PRODUCTS FOR THE DEVELOPMENT OF LATENT FINGERPRINTS ON NON-POROUS SURFACES 3.
26. Sari, S.A., Ningsih, H., Jasmidi, Kembaren, A., Mahat, N.A., 2019. Development of gambir powder as a cheap and green fingerprint powder for forensic applications. Presented at the PROCEEDINGS OF THE 2ND INTERNATIONAL CONFERENCE ON BIOSCIENCES AND MEDICAL ENGINEERING (ICBME2019): Towards innovative research and cross-disciplinary collaborations, Bali, Indonesia, p. 020023. <https://doi.org/10.1063/1.5125527>
27. Sari, S.A., Sinaga, Y., Juwitaningsih, T., n.d. A new latent fingerprint method using natural powder purple sweet potato (*Ipomoea batatas* L. Poiret).
28. Singh Sankhla, M., 2018. Marble Slurry Powder are Using Visualization on Latent Fingerprints on Different Surfaces. *JFSCI* 9. <https://doi.org/10.19080/JFSCI.2018.09.555765>
29. Sodhi, G.S., Kaur, J., n.d. Powder method for detecting latent fingerprints: a review.
30. Srivastava, A., Verma, P., Mukherjee, D., Moza, B., Saha, A., Ujjainia, P., Dhondiyal, P., Jain, P., 2024. A green approach to fingerprint enhancement: The potential of *alternanthera dentata* leaf powder. *IJFMTS* 9, 18–27. <https://doi.org/10.18231/j.ijfmts.2024.005>
31. Suryawanshi, N.S., Nalage, S., n.d. Natural Methods for the Identification of Fingerprint by Using Sandal Wood Powder.
32. Thakur, P., Garg, R.K., 2016. New developing reagent for latent fingerprint visualization: Fuller's earth (Multani Mitti). *Egyptian Journal of Forensic Sciences* 6, 449–458. <https://doi.org/10.1016/j.ejfs.2016.11.007>
33. Trapecar, M., Balazic, J., 2007. Fingerprint recovery from human skin surfaces. *Science & Justice* 47, 136–140. <https://doi.org/10.1016/j.scijus.2007.01.002>
34. V., D., Agrawal, B., Srivastav, A., Bhatt, P., Bhowmik, S., Agrawal, Y.K., Maity, P., 2020. Fluorescent amphiphilic silica nanopowder for developing latent fingerprints. *Australian Journal of Forensic Sciences* 52, 354–367. <https://doi.org/10.1080/00450618.2018.1533036>
35. Vadivel, R., Nirmala, M., Anbukumaran, K., 2021. Commonly available, everyday materials as non-conventional powders for the visualization of latent fingerprints. *Forensic Chemistry* 24, 100339. <https://doi.org/10.1016/j.forc.2021.100339>
36. Van Netten, C., Teschke, K.E., Souter, F., 1990. Occupational Exposure to Elemental Constituents in Fingerprint Powders. *Archives of Environmental Health: An International Journal* 45, 123–127. <https://doi.org/10.1080/00039896.1990.9935936>
37. Weisburger, J.H., 1997. Tea and health: a historical perspective. *Cancer Letters* 114, 315–317. [https://doi.org/10.1016/S0304-3835\(97\)04691-0](https://doi.org/10.1016/S0304-3835(97)04691-0)
38. Yadav, S., Sharma, N., Sharma, S., Gnaneswari, M.D., 2020. Exploring the Potential of using Spinach Powder for the Visualization of Latent Fingerprints.
39. Yuan, C., Li, M., Wang, M., Zhang, X., Yin, Z., Song, K., Zhang, Z., 2020. Sensitive development of latent fingerprints using Rhodamine B-diatomaceous earth composites and principle of efficient image enhancement behind their fluorescence characteristics. *Chemical Engineering Journal* 383, 123076. <https://doi.org/10.1016/j.cej.2019.123076>

How to cite this article: Ruchika Dwivedi1, Himanshu Kothari, Geetika Saxena, Vaishnavi Thakre, Bhawana Jangir. Green Synthesis of eco-friendly fingerprint powders from brewed green and black tea leaves. *International Journal of Research and Review*. 2026; 13(2): 97-115. DOI: [10.52403/ijrr.20260210](https://doi.org/10.52403/ijrr.20260210)

\*\*\*\*\*