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Análise de Impressão Digital no Brasil: Uma Revisão Bibliométrica 2010-2019

Fingerprint Analysis in Brazil: A Bibliometric Review 2010-2019

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Resumo. Neste trabalho são relatados os últimos 10 anos de produção científica brasileira sobre análise de impressões digitais. Assim, por meio da ferramenta de busca da plataforma web of science, foram trazidos de suas bases de dados os trabalhos com pelo menos um autor com afiliação do Brasil. As seguintes palavras-chave foram utilizadas na busca por assunto: papiloscopia, ridgeology, fingermark ou latent fingerprint. Os artigos foram separados por áreas e analisou-se a evolução das pesquisas relacionadas à análise de impressões digitais no Brasil, conforme as perspectivas para o tema no país. Assim, a evolução das publicações mundiais também foi comparada com as publicações brasileiras, considerando evolução, tipo, financiamento e questões de pesquisa.

Palavras-chaves: Papiloscopia; *Ridgeology*; Impressão digital; Impressão latente; Brasil.

Abstract. The last 10 years of Brazilian scientific production on fingerprint analyses are reported at this work. Thus, using the Web of Science platform search tool, the works with at least one author with Brazilian affiliation were brought from their databases. The following keywords were used in the search by topic: papiloscopia, ridgeology, fingermark or latent fingerprint. The articles were separated by areas and the evolution of research related to fingerprint analysis in Brazil were analyzed, as the perspectives for this issue in the country. The evolution of the world's publications was

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then compared with the Brazilian publications, considering evolution, type, financing and research issues.

Keywords: Papilloscopy; Ridgeology; Fingermark; Latent fingerprint; Brazil.

1. Introduction

In 1892, fingerprints were used for the first time to solve a crime, by Juan Vucetich [1]. Since then, fingerprints taken at crime scenes have been considered a powerful tool for identifying victims and authorship. The techniques for obtaining this criminal evidence have evolved over time, allowing extraction on various types of surfaces, using different optical, chemical or physical methods (fingerprint manual). After this process, in general, fingerprints are registered using photographic techniques and their images are analyzed in an automated system (AFIS Automatic Fingerprint Identification System) and compared with databases.

The increase in the number of scientific publications related to the analysis and extraction of fingerprints highlights not only the technical evolution, but the growing importance of the subject. These works seek to propose methodologies to enable the detection and extraction of this trace on surfaces where traditional methods are not sufficient, such as in dark backgrounds and ammunition cartridges. They also seek to obtain other information from these evidences that can contribute to the investigation process, such as the detection of traces of explosives, chemical substances and biological materials[2].

In a recent article, Interpol brings a review of the works published in journals with peer reviews worldwide, in the period 2016 to 2019, on fingerprints and other brands produced by the body. According to the authors, there was a 33% increase in the number of publications when compared to the period from 2013 to 2016[2].

This work aims to analyze the evolution of researches related to fingermarks in Brazil for the last ten years, and to evaluate the state of the art as well as the perspectives for this subject at the country. For this, the evolution of publications around the world will be shown, to then explore the comparison between them and Brazilian publications. It is worth mentioning that an exhaustive review is not the main focus of this work, but rather show the trend

and address the future challenges for the evolution of this branch of forensic science in Brazil. We tried to offer an extensive coverage of the published sources, but it is important to highlight that an exhaustive review is not possible. Despite the numerous studies published, there has been no overview covering the evolution of this issue in Brazil.

2. Methods

For this study, it was considered all databases available on the Web of Science Platform: main collection of the Web of Science, Derwent Innovation Index, KCI Database of Korean journals, Russian Science Citation Index and SciElo Citation Index. The following keywords were used in the search by topic: papiloscopy, rid geology, fingermark or latent fingerprint. Then, the results were filtered to select the articles with at least one author with Brazilian affiliation. The period considered was between 2010 and 2019. It is worth to mention that 28 evaluation criteria are used to include a journal in the Web of Science database, including impact factors, ISSN, and a strict peer review policy. Thus, in this work, only papers published in peer-reviewed journals will be considered. To evaluate the main topics of the publications, it was used a mining text application called Pro Word Cloud, from Orpheus Technology Ltd.

3. Results

In the period from 2010 to 2019, 1269 publications were found. Looking for publications with Brazilian authors or coauthors, 20 works were found, corresponding to 1.5% of the total. Figure 1 shows a map of the world representing the distribution of published works by country, where can be observed China (255), United States (221), England (205), India (160) and Australia (115) responsible for 75% of publications worldwide. Brazil appears in 14th place. The 1269 publications found in the world have an h index equal to 50 and the average citation per item is 11.4. The 20 Brazilian publications have an h index of 6, with an average of 3.8 citations per item, with an average citation per item that is equivalent to only 35% of the world average.

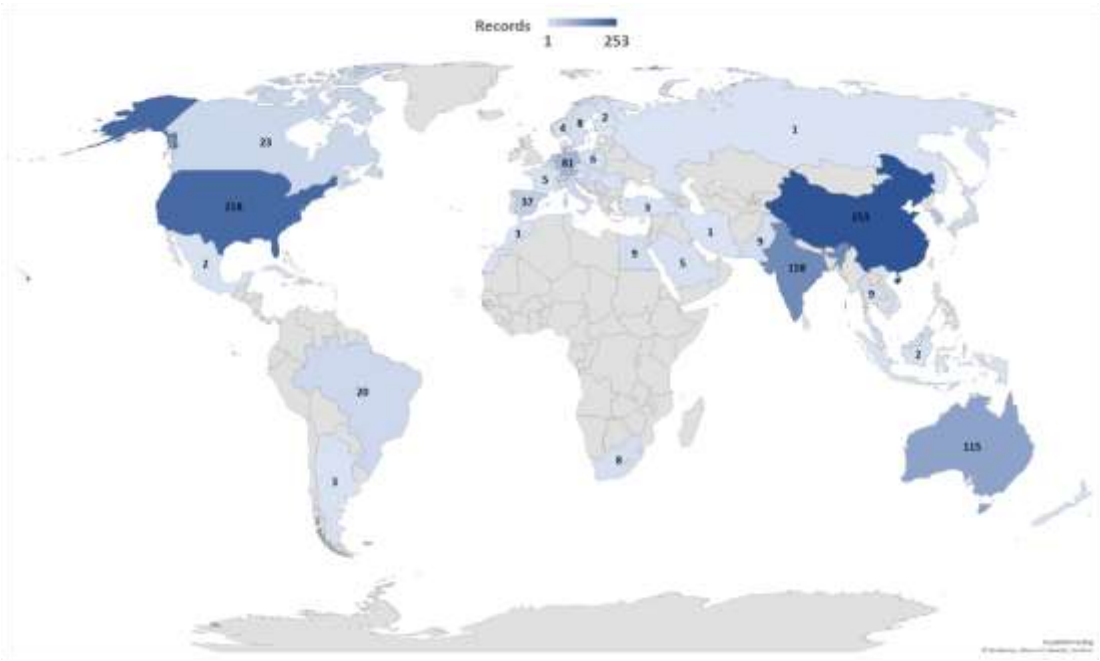

Figure 1. Worldwide distribution of scientific articles related to fingerprint identification published between 2010 and 2019.

The evolution of the number of publications worldwide and in Brazil, considering the period studied, can be observed in Figure 2. A trend of increase in publications can be observed in both cases, showing a growth of 380% and 500%, respectively. It is noteworthy that the first Brazilian article, found according to the methodology adopted, was published in 2012.

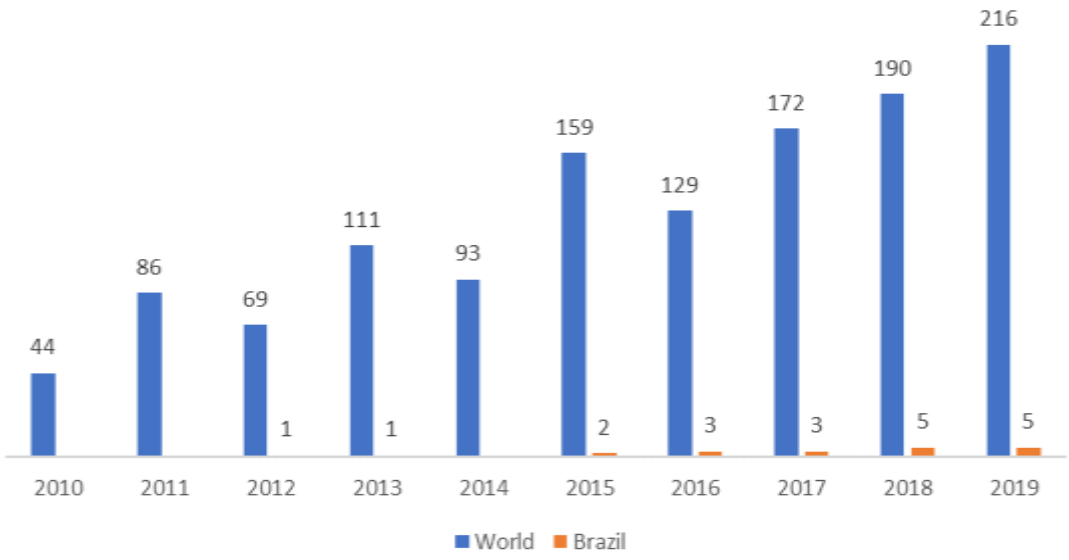

Figure 2. Evolution of the number of publications worldwide and in Brazil.

Regarding the document types, Figure 3 shows the distribution by type. In the world, 74% corresponds to scientific articles, followed by 16% of proceedings paper, which corresponds to 90% of the total. In Brazil, 90% of the material found refers to scientific articles and 10% to proceedings paper.

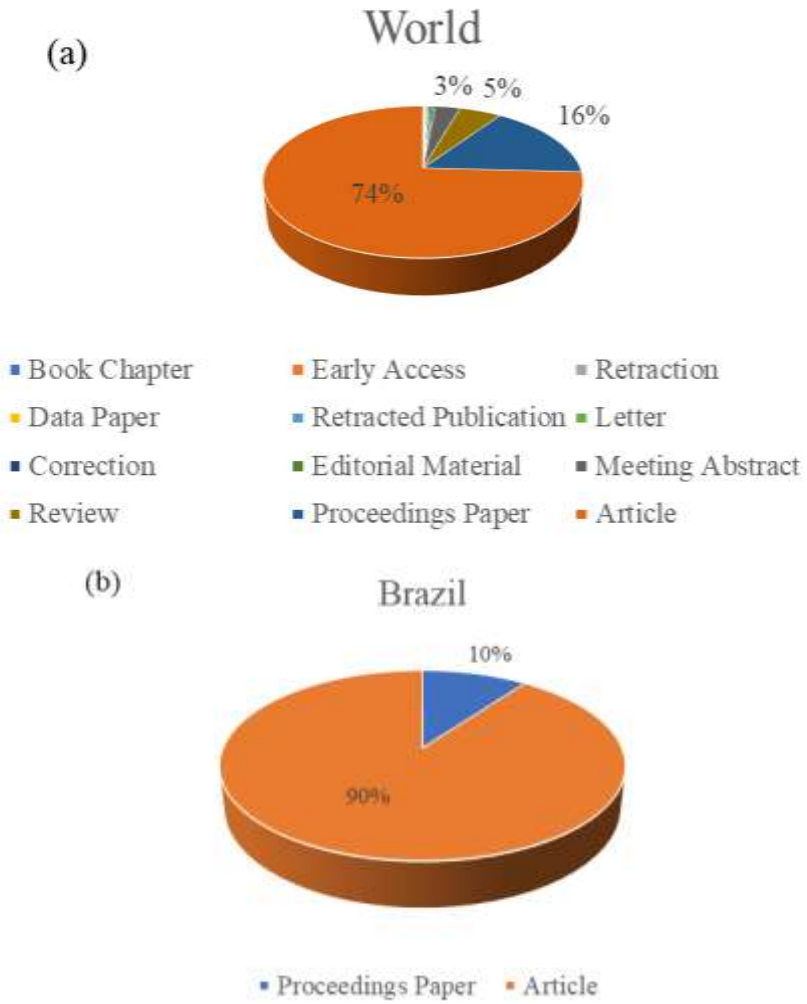

Figure 3. Document type distribution (a) Worldwide and (b) in Brazil.

Research topics, both in the world and in Brazil, can be predominantly framed as forensic medicine, followed by analytical chemistry. The 10 areas with the highest number of studies are shown in Figure 4. In addition to the areas presented in the following Figure, 3 articles with at least one Brazilian author were classified by the Web of Science in the Genetic Heredity category. The others that are not displayed were framed as physics applied, pathology, computer science information systems, chemistry applied, chemical engineering, material science textiles.

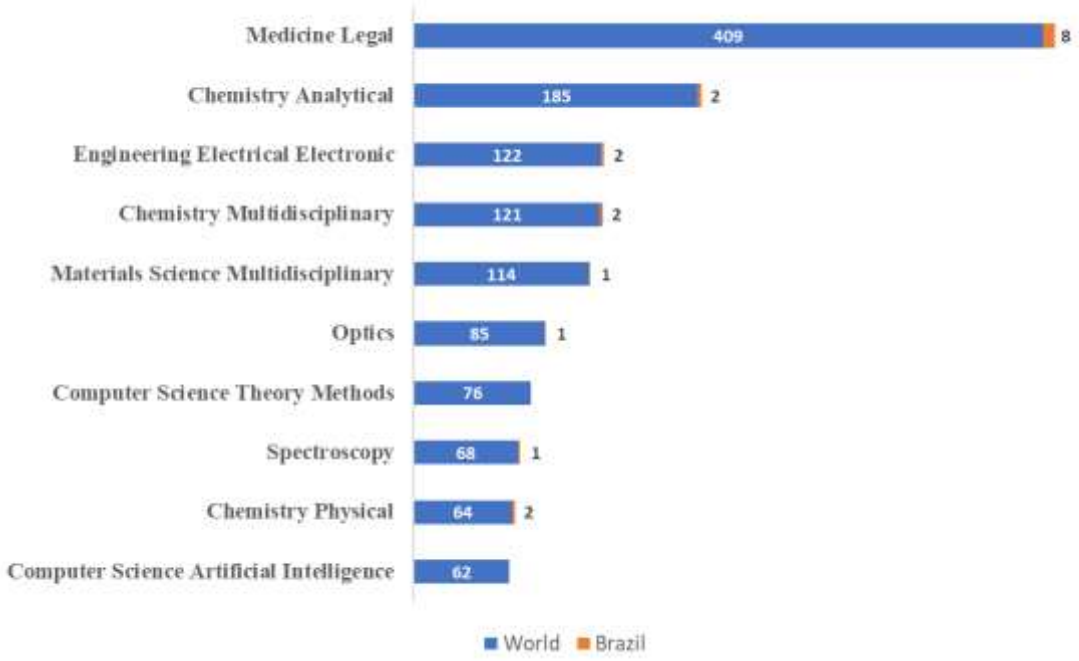

Figure 4. Top 10 research areas considering its number of articles published (worldwide and in Brazil).

The authors of the studies published in the period are linked to 1049 institutions, especially on institutions from India, Australia, Germany, the Netherlands and China. Of the total number of institutions, FBI researchers were responsible for publishing 16 articles, corresponding to 7.3% of the total, considering at least one author with USA institutional affiliation. In Brazil, 7 published articles, (35% of total) had a participation of Brazilian Federal Police´s researchers.

Considering the authors, their employment ties and the origin of the research resources, institutional support seems to be essential for technical and scientific development. Regarding the 1.269 publications found, 807 funding agencies were identified. The National Natural Science Foundation of China deserves to be highlighted. It is an innovative agency that financed 12,8% of these researches. At the first places are institutions from China, Germany, United Kingdom, India, Switzerland, Australia and USA, financing 27,2% of the total. The Brazilian Agency, also named CAPES, is responsible for 11 researches (0.9%), 12º place in the rank. Other Brazilian supporters should be cited: CNPQ, ABRAPOL, FINEP, FAPITEC, FAPES, FAPDF, EMBRAPA, Brazilian Federal Police, UFRGS, FAPEMIG, FENAPEF.

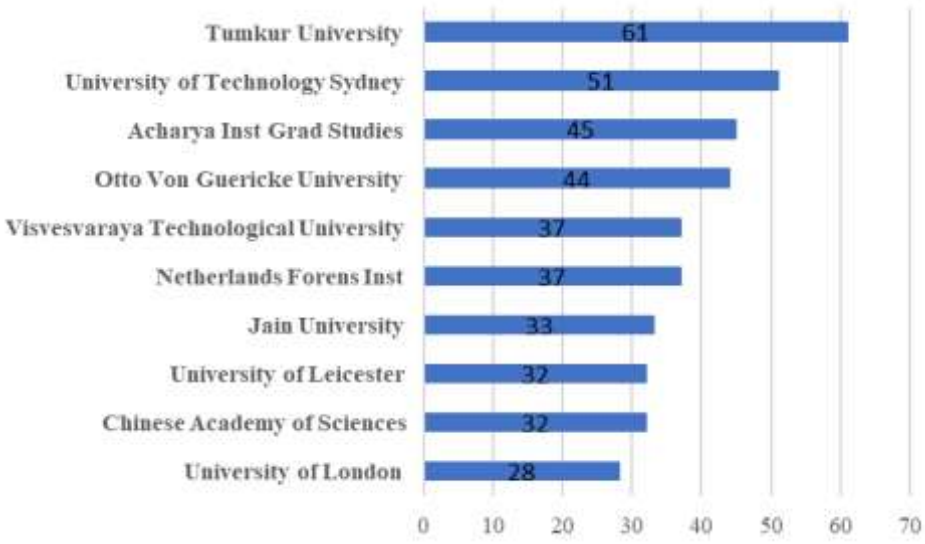

Figure 5. Top 10 institutions considering the authors affiliation.

It is worth mentioning, that considering the 1269 studies published in the period, many forensic studies have been carried out in order to gain a better knowledge about the endogenous and exogenous components of fingermark. These studies concentrated on the chemical imaging of fingermarks and spectrometry as can be observed on Figure 6.

Figure 6. The main research subjects used at the 1269 document titles, obtained by the free minning text tool (Pro Word Cloud).

Considering the articles published with at least one author with Brazilian affiliation, the focus of the studies at the same period was the synthesis and applications of new fingerprint developers materials[3-10]. These studies aimed to identify low-cost materials, some based on natural resources, which presented greater contrast in different situations, such as dark backgrounds and metallic surfaces, when compared to traditional developers. The use of spectroscopy for identification of methamphetamine in fingerprints was studied[11], as well as a fingerprints aging method[12]. The monitoring of the physical characteristics of the fingerprint as a function of time was the aim of one article[13]. Protocols for the use of traditional developers for the development of fingerprints on exploded or unexflated gun cartridges have been proposed and tested[14-16]. Another topic widely covered refers to studies about the collection of genetic material from digital printing[17-19]. Finally, the importance of fingerprint analysis for the identification of false documents was also studied[20]. Details of each article are provided bellow.

In relation to the proceeding papers found, one refer to the investigation of the influence of lighting in the acquisition of latent fingerprints obtained with cell phone[21] and the improvement of the disclosure of fingerprints left at crime scenes for real-time criminal identification[22].

The differences between the core themes in Brazil and the rest of the world result in a better understanding of important aspects of the level of scientific investigation on the country. On one hand, the developed studies from the world looked for new techs and methodological improvements, while the Brazilian's studies are focused on identifying cheaper and easier ways to solve daily challenges, with few frontier improvements.

3.1 Fingermark developments

Adhesive tapes are commonly used in criminal endeavors and are therefore an important piece of evidence to be examined in order to obtain information regarding the authorship of a crime. Thus, the development of fingerprints on adhesive tapes can help to identify a criminal. In cases of robbery, kidnapping, rape, etc., this material can be used to immobilize the victims. In situations involving explosives, adhesive tapes are often used as subsidiary material.

Barros[3] developed a new fluorescent dye as an alternative to commonly used developers (crystal violet, cyanoacrylate, developer powders etc.), which in some cases, such as in dark colored strips, have limitations. Exciting the fluorescent material to a UV radiation with a wavelength of 325 nm, Barros carried out tests with fingerprints of three individuals (2 men and 1 woman) and demonstrated through the tests on different types of adhesive tapes and different colors, the contrast superiority of its developing agent compared to crystal violet. It also demonstrated the potential and efficiency of its dye with its high sensitivity and selectivity with the fingerprints deposited on the sticky part of the adhesive tape. The material is soluble in water (appeal to green chemistry), it has high thermal and photothermal sensitivity, in addition to not requiring complex instrumentation or pre or post-treatment protocols for use.

Sobral *et al.*[4] proposed a developer based on Y_2O_3 nanoparticles (NPs) doped with rare earth ions: Tb^{+3} and Eu^{+3}, to obtain fluorescent images of fingerprints, when subjected to UV light (260 nm and 310 nm). Fingerprints were obtained by depositing the index finger on a glass slide. Then, the NPs were sprinkled, and the excess was removed. After excitation with UV light, the images were obtained using photographs. The authors state that the nanoparticulate material has a potential forensic application and it can be used for the development of latent fingerprints, facilitating the contrast and detection of these vestiges.

Andrade *et al.*[5] studied the use of gold nanocomposites as a catalyst in the reaction to reduce organic dyes and also as a developing agent for latent fingerprints. For the last case, fingerprints of male and female volunteers, between 20 and 30 years old, were deposited on different substrates and, after the application of the gold nanocomposites, the samples were stored, photographed and subjected to time and temperature stability tests. After this process, the results were compared with 3 conventional staining methods (gold nanoparticles stabilized with citrate, silver nitrate and violet crystal). The results showed that this method can be applied with high sensitivity, accuracy and the possibility of use on a variety of substrates, porous or not, including glass, polymers, metal, leather, ceramics and wood, in addition to being a durable and thermally stable.

The considerable development of crime scene processing is amplifying the role of evidence, while making it possible to obtain proof from very small blood marks. Barros *et al*.[6] studied the potential of three dyes (named HB-7, HB-9 and HB-11), all soluble in water and fluorescent in the green region when exposed to UV radiation (365 nm), to reveal drops of blood and fingerprints with blood in different types surfaces. Porous surfaces such as ceramics and paper were studied, as well as semi-porous to non-porous surfaces such as painted aluminum, steel laminate, glass, painted and unpainted polypropylene. The fingers of three volunteers (two men and one woman) were placed in contact with blood and the bloody fingerprint was deposited on the different surfaces studied. The study demonstrated that the dyes can be applied successfully on the tested surfaces. The method proved to be sensitive, selective and effective, requiring no pre or post treatment or complex instrumentation. The authors also drew attention to the low cost of preparation.

Barros and Stefani[7] developed a powder based on the benzazole dye and silica matrix for developing fingerprints on different non-porous (glass, steel sheet, polyethylene and aluminum) and porous surfaces (paper, wood and ceramic), of different colors, which demonstrated a great potential application due to its photoluminescence property. Fingerprints of 10 volunteers (5 men and 5 women, aged between 20 and 41 years old) were deposited on the surfaces after donors rubbed their fingers on an oily part of the face. To observe the revealed fingerprint, a UV lamp (365 nm) was used, and a photographic record was performed. The results demonstrated that the high fluorescence emitted by the developing powder creates a self-contrast between the fingerprint and the color-independent surface, making it easily detectable. In addition, this material is low cost and, when using a silica matrix, it is biodegradable and non-toxic. Even though the fingerprints are stored for long periods, there was no damage to the process of developing.

Nicolodi *et al*.[8] developed latent fingerprints method using condiments for forensic application with a didactic and contextualized approach in the teaching of Undergraduate Chemistry. Condiments containing natural dyes were selected in order to promote the contrast between the revealed fingerprint and the surface. After the extraction process, the following dyes were obtained for use in the study: *C. verum, C. longa, L. nobilis, C.annuum*. The fingerprints

were deposited on glass and plastic surfaces, in the natural form (the donor washed his hands with neutral soap, and continued with routine activities for 30 minutes, before depositing his fingerprints) and sebaceous (the donor fingered his fingers in oily parts of the body such as forehead and nose before depositing fingerprints). The samples were left to rest for 24 hours and then, the development process was carried out using proper brushes and condiments. The dye extracts were also subjected to thin layer chromatographic analysis (CCD) and gas chromatography coupled with mass spectrometry (CG-EM) for didactic purposes of interpretation of results. An evaluation scale was developed where the dye that stood out the most in revealing vital and natural sebum impressions on both surfaces was *C. verum*. The condiments used proved to be a good developing for latent fingerprints, on plastic and glass. Finally, the selected extracts have low toxicity, low cost and easy access, which makes this method applicable also in the classroom.

Balsan *et al.*[9] analyzed the application of different chalcone powder types (natural products belonging to the flavonoid family) as a developing agent for latent fingerprints. The fingerprint samples were deposited on plastic and glass surfaces and then the results were compared, where the glass surface was better evaluated. Three chalcone analogous compounds were synthesized and tested, where the compound that presented the best potential revealing was E-3-(3-nitrophenyl)-1-(phenyl)prop-2-en-1-one. The study aimed to demonstrate that a developer agent, which can be synthesized, according to the principles of clean chemistry and can favor the cost reduction, can be used as an option instead of conventional ones, since traditional developers have high import costs and chemical components. The results were considered satisfactory due to the quality of the development of the fingerprint and the reduction of residues generated to the environment, also reducing the exposure of experts, although the method has limitations, such as the type of surface.

A methodology based on the natural fluorophores fluorescence was studied by Oliveira *et al.*[10] to increase the contrast between the fingerprint and the background. For this, resveratrol (a low-cost, natural and non-toxic fluorescent substance) and photography techniques associated with UV light illumination (365 nm) were used to increase the contrast of the latent fingerprint deposited on a porous wooden surface. A better visualization of the developed

fingerprint was obtained, compared to the black powder. The results indicated that it is a technique with potential application for porous materials.

3.2 Detection techniques for exogenous materials from fingermarks

De Souza *et al.*[11] studied a methodology for the detection of methamphetamine (MA) using surface enhanced Raman spectroscopy (SERS). The adopted strategy involved the use of active SERS substrates of a film with silver nanoparticles dispersed in agarose gel (AgNPs / Agar) deposited on glass and aluminum sheets. In addition to finding methamphetamine in solutions at concentrations up to 10^{-5}mol/L, the authors made adjustments to the experimental data to the Langmuir, Frumkin and Freundlich isotherms in order to better understand the adsorption process between the drug and the substrate used. The studied substrate also made it possible to identify MA in a fingerprint contaminated with a 0.01mol/L solution (ca. 190µg) of the drug. The SERS spectra at different fingerprint locations showed relatively high signs of adsorbed MA, suggesting that this methodology is promising to be applied in the detection of other drugs or other substances of forensic interest.

3.3 Fingermark aging techniques

Barros *et al.*[12] developed a methodology to determine the aging of a latent palm print based on the substantial differences observed due the relative proportion of the components, as a function of time, that affect the morphology of the papillary ridges. For this purpose, 20 volunteers (10 men and 10 women) aged between 19 and 44 years, were considered. To evaluate possible influences, information from the volunteers was collected, such as gender, age, medications, health, diet and habits. The production of palm print samples was performed without previous preparation. The individuals performed their normal activities and then pressed the hypothenar area of the left palm on microscope slides, with controlled force for 10 seconds. The impressions were developed as soon as they were produced and the morphometry of the ridges were observed over a period of 30 days, at intervals every 5 days. Statistical tests were applied to evaluate reproducibility and the effect of time on the morphometry of palm prints. The study concluded that it is possible to detect the reduction of the thickness of the ridges and the percentage of visible ridges as a function of

time. No significant gender-related differences were found. The use of cosmetics may have influence at this aging process.

3.4 Fingermark composition and evolution with time

Spectrometry has delivered important results regarding the analysis of organic molecules. Barros *et al*.[13] analyzed the chemical composition of fingerprints using a surface assisted laser desorption mass spectrometry technique (SALDIMS). The samples were obtained by 3 (three) donors, one female and the others male. Donors deposited their fingerprints on a MALDI plate, which were analyzed before and after the development of the fingerprint with the application of magnetic powder. The authors also used silica mesocellular foam (MFC) as an ionizing agent for laser desorption / ionization analysis (LDI-MS). Information was obtained regarding ions related to endogenous and exogenous molecular components, including possible human sebum lipids and quaternary ammonium cations commonly present in cosmetics. The method presented is non-destructible. Promising and reproducible results were obtained for both developed and undeveloped fingerprint samples.

3.5 Cartridges

Although the work of finding fingerprints on fired cartridges fits as a developing technique, it was decided to treat this type of examination under a specific topic, given the difficulty of developing fingerprints in these cases and the relevance of studies in this field of forensic science. Girelli *et al.*[14] studied the joint application of developers commonly used in the forensic routine to reveal fingerprints on fired and unfired cartridges and on brass discs. The best suggested sequence of developers, in both cases, was cyanoacrylate, gun bluing and basic yellow. The authors also concluded that, for the unfired cartridges, the fingerprints produced on this surface did not present significant damage when they suffered friction with the metal of a pistol, during loading and injecting process. Regarding brass discs, a curious phenomenon was observed when it was heated to a temperature of 200 ° C and subjected to gun bluing solution. The developed was inverted, with a light background and dark ridges.

Deepening the previous study, Girelli *et al.*[15] tested other fingerprint developer's sequences including ardrox. The fire effect on the fingerprint

deterioration in fired cartridges was also studied. The authors claim that the successful recovery of fingerprints from these fired cartridges depends not only on the resistance of these to the firing process, but also on the appropriate selection of the development methods. Another objective of the article was to contribute to a better understanding of the brass surface properties, to help in the search for the best choices for practical situations. Four groups of developers were tested. For the tests, 240 fired cartridges were used, separated into 12 groups of 20. For the control group, 24 intact cartridges were used. The fingerprints of the control cartridges were obtained from one donor, who washed his hand with soap and water, at least 20 minutes before deposition. In the face of studied developers, cyanoacrylate, gun bluing and one of the fluorescent dyes, basic yellow or ardrox, showed better results. Analysis of the effects of heat brought strong damaging evidence to the fingerprint during shooting. The fingerprints revealed on the fired cartridges, deposited before the deflagration, presented better quality than those deposited after the shot.

Using previously proposed methodologies, Girelli and Segatto[16] presented a fingerprint development study on ammunition cartridges. The authors used 1431 cartridges obtained from crime scenes. Of this total, 140 were unfired and 1291 were fired. The cartridges were divided into different types of weapons and calibers. Fingerprints were recovered using cyanoacrylate, followed by immersion in gun blue and, at last, applying basic yellow fluorescent dye. A rating with a scale of 0 to 4 was developed as a basis for assessing the fingerprint development quality on each cartridge, which was carried out based on the analysis of two independent experts. Most of the cartridges (1247 fired cartriges and 134 unfired cartriges) were classified as grade 0. The fingerprints obtained in a satisfactory way were analyzed in the Brazilian Federal Police AFIS system. It resulted on the first case in Brazil of identification of a suspect from a fingerprint revealed on a fired cartridge. Despite the large number of cartridges analyzed, it was possible to reveal fingerprints with sufficient quality in only a few cases. According to the authors, the way the cartridge is handled, before or after, is the main cause of the low degree of fingerprint development in this material.

3.6 DNA and fingermarks

Oliveira *et al.*[17] studied several methodologies and proposed a standardization of techniques for collecting and extracting DNA from fingerprints deposited on glass and metal surfaces (classified as non-porous substrates) to adapt these methods for military application. Three volunteers deposited their fingerprints by pressing the surface of 24 slides for 30 seconds. The DNA was extracted on the same day using two swab solutions, one containing sodium chloride (NaCl - 0.9% w/v) and the other sodium dodecyl sulfate (SDS - 2% w/v). Glass sheets were covered with aluminum foil to represent a metallic surface. The isolation and quantification of the genetic material were carried out using kits available on the market. The PCR results showed an amount of DNA ranging from 0 to 20pg. The comparison between the two surfaces did not show significant differences in the percentage of alleles obtained. The authors found differences in the amount of genetic material collected depending on the swab solution used.

The relation between the application of fingerprint developers such as magnetic powder and common black powder in the development of fingerprints and the feasibility of obtaining the genetic profile of these developed fingerprint was studied by Alem *et al.*[18] For this, 40 volunteers rubbed their index fingers on their faces and hair. Then, they pressed their finger on glass slides for 30 seconds. Half of the fingerprints were developed with common black powder and the other half with magnetic powder. After the development, DNA collection was performed using a double swab, soaked with a 0.9% NaCl solution and a dry one, both sterile. Then, the genetic material was extracted by physical and chemical processes. The efficiency of DNA recovery, in relation to the samples studied, is based on the STR analysis. Considering fourteen alleles for the quantitative assay, a higher DNA yield was obtained for the fingerprints developed with magnetic powder. However, in the STRs analysis from the fingerprints revealed with common black powder, 66% of the alleles were recovered, while the genotyping of the fingerprints revealed with magnetic powder showed recovery of 35% of the alleles. Thus, the magnetic powder interferes more significantly in the genotyping from fingerprints. The authors also considered the fingerprint composition and its surface where it was deposited as factors that can affect the genotyping process. The study indicated

that for fingerprints deposited on glass surfaces the use of common black powder for development is a technique indicated to provide a better genetic analysis, in case it is necessary.

Tobias *et al.*[19] investigated the relationship between the pressure and the quality of the DNA deposited by touch. Two volunteers deposited their fingerprints on special paper and were scanned and the prints measured by image software to calculate each area. A polycarbonate plate was fixed on the top of a scale and the volunteer pressed with the fingers of one hand for 1 min, with applied pressures of 4 (light), 21 (medium) or 37 (high) KPa. Immediately after the deposition, the genetic material was collected by a swab (n = 36) by a DNA kit. The observed data suggest that the amount of DNA deposited varies from person to person, with no significant variations being observed when buying the different hands of the same individual. An increase in DNA deposition was observed with increased pressure.

3.7 Documents Falsification

Work presented by Girelli[20] aimed to highlight the importance of fingerprint analysis in the examination of documents, originals or copies. In this study, 100 fingerprints obtained through web search were considered, submitted to the AFIS system of the Brazilian Federal Police, which in turn presented candidates with correspondence. The analysis of fingerprints available on the web has shown that they are often used to forge documents in Brazil. Thus, this analysis can contribute to the detection of counterfeits. Some visual characteristics of fingerprint images may be useful for this purpose, such as: image boundaries and contours, crest failures caused by excess or lack of ink, and presence of watermarks and artifacts from the background. Many fingerprints obtained on the web presented some type of image editing, the most problematic being the lateral reversals, given the difficulty associated with its detection. The application of a standard procedure by the Federal Police in the state of Espírito Santo presented a satisfactory cost-benefit ratio, indicating the recurrent use of laterally reversed fingerprints in false identification documents. Thus, the author suggests the implementation of tools that allow the identification of inverted images in AFIS, with lower risk of error and greater speed in the process of identifying counterfeits.

4. Final considerations

Fingerprints are very important evidence for forensic investigation, as they can establish the authorship of a crime. Their understanding, more and more in-depth, can promote new techniques of revelation, supply of chemical profiles, age and even physical characteristics of those who produced them. Thus, investment in research in this area is extremely important. However, the lack of information on the results obtained as a result of technological improvements may diminish the authorities' interest in promoting research involving fingerprint analysis. With less institutional support, the scientific criminal research agenda in fingerprint analysis is limited in Brazil. There was also little evidence of formal research networks between crime scene investigators and the academy, with knowledge production being the result of individual and sparse initiatives.

Brazilian participation in international scientific production was only 1.5% between 2010 and 2019. On the other hand, the growth rate of national production was 500%, against 380% in the world. Although these results do not allow affirming a consolidation of the importance of this theme, it certainly showed a growing interest in this issue of Forensic Science in Brazil.

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