 DOI: 10.32870/zcr.v8i15.223 ISSN: 2448-8437

Chlorophyll printing by nature (through the action of photosynthesis): an alternative photographic process where images are developed on natural leaves

Fotografía impresa al natural: la clorotipia como procedimiento alternativo de impresión de imágenes en plantas

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Received: 29 of november of 2023
Accepted: 03 of january of 2024
Published:

Abstract

This research focuses on the chlorophyll printing technique, that uses the photosynthesis process of natural leaves to create image prints. Recently, within the panorama of contemporary visual arts, it has been used by different artists in various proposals with an approach alternative to the traditional one; Its predecessor is the primitive processes of photographic printing. The objective of this article is to develop a workflow for the technique, which covers the choice of the type of leaf, the preparation of the original image, the different climatic variables for printing, posterior care and the final presentation of the product. We worked with three type of plants that can be commonly found in the streets and homes of the metropolitan area of Guadalajara, Mexico, on which three photographic images were printed. It was possible to discern in the results that the choice of the type of leaf, taking into account its color, defines the tonality of the print; that the previous treatment of the photographic originals, placing emphasis on its histogram (which shows the distribution of lights) and its subsequent manipulation of the curves, determines the tonal scale of the print, in addition there has been found that the results vary depending on climatic variables: UV index, temperature and humidity. Likewise, the use of a control scale allowed the calculation of sun exposure time.

Keywords: print, photography, photosynthesis, chlorophyll printing, leaves

Resumen

Esta investigación se centra en la técnica de impresión de la clorotipia, la cual utiliza el proceso de fotosíntesis de las hojas naturales para generar impresiones de imágenes. De manera reciente, dentro del panorama de las artes visuales contemporáneas, se ha venido utilizando por distintos artistas para generar propuestas con un soporte distinto a lo tradicional; sus antecedentes se encuentran en los procesos primigenios de impresión fotográfica. El objetivo de este artículo es desarrollar un procedimiento de trabajo de la técnica, que abarque la elección del tipo de hoja, la preparación de la imagen original, las distintas variables climáticas para su impresión, los cuidados posteriores y la presentación final del producto. Se trabajó con tres plantas que se pueden encontrar de manera habitual en las calles y hogares de la zona metropolitana de Guadalajara, en México, en las cuales se imprimieron tres imágenes fotográficas. Se pudo discernir en los resultados que la elección del tipo de hoja, atendiendo su color, influye en la tonalidad de la impresión; que el tratamiento previo a los originales fotográficos, poniendo énfasis en su histograma (el cual muestra la distribución de las luces) y su posterior manipulación de las curvas, determina la escala tonal en la impresión, además de que los resultados se ven alterados, dependiendo de las variables climáticas: rayos UV, temperatura y humedad. Asimismo, el uso de una escala de control permitió el cálculo del tiempo de exposición al sol.

Palabras clave: impresión, fotografía, fotosíntesis, clorotipia, plantas

 DOI: 10.32870/zcr.v8i15.223 ISSN: 2448-8437

Introduction

Within the field of visual arts, there are various image printing techniques, one of which is among the most studied and practiced and depends on analog and digital photography. The traditional chemical process is still practiced today, despite the monetary costs it represents and the scarcity (in some areas) of the materials for its execution. It is worth mentioning that, according to Newhall (2002), "the oldest example of what Daguerre came to call the daguerreotype, shows the possibilities of a new graphic medium that would revolutionize the printing of images" (p.35). This workflow, which is more than 200 years old, is still practiced, but its execution is complex and expensive, since, indicates Pavao (2001), "it is a photographic image that is based on a layer of polished silver on a copper plate" (p. 18). Since materials that are not easily accessible are needed, few people can carry it out.

When it comes to digital photography, given the immediacy, it seems that fewer and fewer images are printed, the important thing is to capture and share in the moment. As Fontcuberta (2017) mentions, "images circulate on the internet at breakneck speed, they have stopped playing the passive role of illustration and have become active, furious, dangerous" (p. 8), and that is because, given the amount of images that can be seen behind the screen, it seems that it is not necessary to retain them on some physical medium.

Alternative and primitive photographic printing processes are not new in our context, but, for the most part, they absolutely required the use of some external chemical component. Since the beginning of the 18TH century, according to Eastlake (2019), "the process later known *as-photographic drawing,* which included leaves, lace, insect wings, or any semi-transparent and flat substance placed on the prepared paper and exposed to the direct action of the sun, captured the contours of the forms" (p. 19). In this workflow, the use of silver nitrate was essential, but the image was not fixed to the paper. It was in the middle of that same century that John Herschel and Robert Hunt had concerns and, as Eastlake (2019) mentions, they experimented with "the sap of beautiful flowers, [...] the poppy, the rose or the senecio splendors, intending

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to capture delicate images, although almost always fleeting" (p. 33), which speaks of the interest in printing and, above all, experimentation.

In the 19th century, according to Pavao (2001), "some photographers, called pictorialists, then developed more artistic copying processes, which allowed manual intervention on the image at the author's will" (p. 37), which gave them greater freedom and creativity, very much in line with painting, since they believed that this allowed them to get closer to the artistic. These first searches laid the foundations for photographers to begin to have a level of artistic expression in their work and not only record the reality they perceived.

For contemporary artistic expression, these backgrounds of experimentation are important, since, currently, the use of materials and the way in which they are linked to the message that is to be communicated are a fundamental part of the creator's concrete proposal.

This brief historical overview of alternative printing processes allows us to reach chlorophyll. As described by Newhall (2002), "the ancients had observed that light changes the nature of many substances; For example, the chlorophyll of vegetation turns green in the light, or colored tissues turn pale" (p. 9). With this background, it can be inferred that the observation of the plant environment allowed the first indications (although not in a concrete way) of this workflow.

Chlorophyll is a direct image printing technique, in which it is possible to replace gelatin silver-based photographic paper with natural green vegetable leaves, and it is in this sense that it is distinguished from the traditional, since industrialized chemicals are not used. and its process is linked to photosynthesis, since, indicates Manrique Reol (2003), "the primary function of chlorophyll is to absorb light energy" (p. 4) and this occurs mainly due to climatic conditions and variables, as well as the chemical composition (chlorophyll) of the plant leaves, which is their main support and emulsion. According to Johanna Ruth Epstein, director of the Smithsonian Design Museum, in the catalog of works In the *Eclipse of Angkor* (2009), Binh Danh "at university invented a method, which uses photosynthesis (the natural interaction between sunlight and chlorophyll) to make prints of leaves from photo negatives" (p. 16). We can infer that his invention is the result of the artist's constant observation of nature. This being the case, this process (although relatively young) may be relevant, since it is considered a powerful aesthetic-creative-experimental alternative in the development of an artistic process and product; hence the importance of having greater knowledge of its process and execution.

Danh, is an American artist who has a bachelor's degree in Photography from San Jose State University and a master's degree in Fine Arts from Stanford University. His topics of interest are related to war and

 DOI: 10.32870/zcr.v8i15.223 ISSN: 2448-8437

migration, since from an early age he had to emigrate with his family to the United States, due to the havoc caused by the war in Vietnam.

For him, the use of the chlorophyll technique is vital in his creation process, as he mentions in an interview for the electronic magazine Lomography (2016). "In the case of my work, a chlorophyll imprint expresses a connection with nature. The imprint, being a leaf, came from nature" (p. 1), which is why, for his Immortality: *The Remnants of the Vietnam and American War* series, he made chlorophyll impressions of that historical event (see figure 1).

Figure 1. *Immortality: The Remnants of the Vietnam and American War. Source: Lomography, 2016.*

To do this, he used images published in the magazine *Life* and some others from history books about the Vietnam War, which became the leitmotif to create a dialogue and rapprochement with his people and the ravages of the war conflict, as he relates it to *Lomography* (2016). "Art could be a vehicle to help my community understand what is happening, like in a war" (p. 1). The leaves he used came from that territory plagued by destruction in those years, which demonstrates the strong connection he has with nature and its people, very important elements for the reading of his artistic project.

On the Mexican scene, professional photographer David Morales has been working with the chlorophyll technique for a couple of years, as he refers in an interview with Ríos Navarrete (2023) for the newspaper *Millennium*. "The technique that I began to develop is called chlorophyll. This is using the leaf of a plant as photographic paper, taking advantage of its sensitivity, and that is where I start" (p. 1). This led him to experiment with a plant that is quite controversial in the political field, cannabis.

In the country, its consumption has been present for several decades, but as Rosen and Zepeda Martínez (2015) mention, "after taking office as President of the Republic, Felipe Calderón (2006-2012) launched the war against drug trafficking, and during his six-year term, approximately

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70,000 people were violently executed" (p. 2). It is in this scenario that Morales' work acquires relevance, since it is a plant that is historically related to a national health and security issue and, as he mentions in the interview with Ríos Navarrete (2023) for the newspaper *Millenium* "I wanted to develop the plant, culturally and artistically, to change people's vision a little, because from 2006 to 2012, more or less, there was the drug war and it was stigmatized. (p. 3)." In that sense, in his project Invasion of Plant Leaves, he uses iconic characters from Mexican culture, such as Frida Kahlo, Diego Rivera and María Sabina, to print them on the cannabis leaf, as seen in figure 2.

Figure 2. *From the series Invasion of Plant Leaves.*
Source: Elaborated by David Morales.

It is a gesture that is evocative, since it works with a leaf that politically has negative attributes, but that, when transferred to the realms of art, acquires another reading, since it is no longer just about marijuana, as it is colloquially called. know the cannabis leaf, but a leaf that carries aesthetic overtones and recognition of Mexican culture. His work has been exhibited at the Hemp and Marijuana Museum, La Casa Frida Kahlo and the Cannabis Museum in Amsterdam, Netherlands.

The aforementioned artists, within their artistic proposals, make very general mention of the technical process of chlorophyll, that is, their main interest is in the aesthetic-conceptual search of their work and, therefore, they do not describe in a general way. systematized the technical workflow that prioritizes the essential variables, such as the prior preparation of the positive, considering the types of lighting, the dynamic range and the histogram of the original; o manipulation of curves and weather conditions: temperature, UV rays and humidity, to obtain an optimized result.

It is, in this context, that the present investigation will allow us to deepen the topic of the chlorophyll technique in three different types of leaves that are commonly found in the metropolitan area of the city of Guadalajara, Mexico.

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Theoretical foundation

Human beings, guided by their restlessness and curiosity, developed one of the first methods to project an image, this was the camera obscura. As Antonini (2015) refers, "this ancient technique was described by Aristotle and drawn by Leonardo Da Vinci, who, like many artists of his time, projected images in a camera obscura onto paper as an aid in drawing" (p. 14). But, at the beginning, it was a fairly large room, which for many made it difficult to use. Much later, the camera lucida was invented, which, according to Newhall (2002), "was designed in 1807 by William Hyde Wollaston, an English scientist. The drawing paper was spread out flat. A glass prism was placed above it, suspended at eye level by a bronze arm" (p. 11). It only resembled the camera obscura in name, since it could be transported, since its size allowed it, although its operation was somewhat complex.

Now, these technological advances were important, but they still did not achieve that, based on light, the image was printed, according to Newhall (2002). "The first person who tried to record the image of the camera using the action of light was Thomas Wedgwood" (p. 13), since he had knowledge of the camera obscura, so, continued with Newhall (2002) "shortly before 1800 he began his experiments, sensitizing paper or leather with silver nitrate; He placed flat objects on top [...] and exposed the whole to light" (p. 13). These experiments can be considered as a precursor to what would eventually be known as the daguerreotype, since, according to Hacking (2013), "in January 1839, it was announced to the world that it was possible to capture the image that was seen." in a camera obscura" (p. 8) and with this began a new era for the creation and printing of images, as it marked a watershed after its viability was accepted by the French Academy of Sciences.

Later, and since the daguerreotype was complicated to handle, a series of printing techniques were created, such as photoengraving, a means for reproducing photographic images with printing ink, according to Newhall. (2002). "In 1858, Talbot improved his process by sprinkling bichromate gelatin with resin, [...] The result, which Talbot called photoglyphic engraving, became the basic foundation of photoengraving" (p. 251). Then, experimentation continued to increase and the carbon process was developed, which according to King (2013), "was introduced in 1864 by the Englishman Joseph W. Swan, who used a paper support, coated on one side with a solution of pigmented gelatin, known as carbon tissue" (p. 1), a workflow was highly valued by photographers of yesteryear, as it allowed them to speed up their prints.

With the exponential growth with which printing techniques were developed, a group of photographers, in their desire to try to elevate photography to an artistic level, gave rise to a movement known as pictorialism, Hacking refers "this photography is characterized by techniques and effects." taken from the graphic arts. Although, in general,

 DOI: 10.32870/zcr.v8i15.223 ISSN: 2448-8437

pictorialist images came from very defined negatives" (p.12), which, as mentioned above, brought photography closer to art.

Another technique that was attractive and recurring due to its easy handling was cyanotype, which, according to Moreno Sáez (2007), "is an early technique introduced in 1842 by the English astronomer and chemist Sir John Frederick William Herschel" (p. 4). It was a contact printing workflow, where the result became a Prussian blue tone. Now, along with the growth of these printing techniques that continued to depend on external chemical agents, the properties of the action of light on nature were explored. Zuluaga (2023) indicates that "Mary Somerville, Scottish mathematician and scientist, was one of the pioneers in extensively studying the properties of plant juices and extracts exposed to light rays" (p. 2). With his experimentation, he allowed an important step to be taken, since it gave rise to the development of what is known as anthotype, a process in which some extracts of plants, fruits or flowers can be used as a photosensitive emulsion to the sun's rays, that is, without the presence of chemical agents for printing an image, although the duration was ephemeral.

Unlike anthotype, in chlorophyll printing the chlorophyll of plants is used as a direct emulsion for printing images, this through the organic process of photosynthesis and without the use of any other processed chemical agent. Currently, with the attention paid to the natural-organic from different fronts and given the possibility of being friendly with the environment that surrounds us, this technique has acquired great relevance as an ecological alternative for printing images and with a great scope. aesthetic-creative-discursive in the field of contemporary visual arts, since it allows experimentation and aesthetic conceptualization of an artistic product.

Methodological design

Chlorophyll printing is a process of directly printing images on natural green plant leaves, mainly using UV rays emitted by the sun, that is, from photosynthesis. Although there are similarities about the chemical photographic printing workflow, it should be noted that there are two important differences: a dark room is not necessary and chemical agents are dispensed with, which makes it an environmentally friendly alternative. In a Figure 3 it could be observed the workflow of the hole process.

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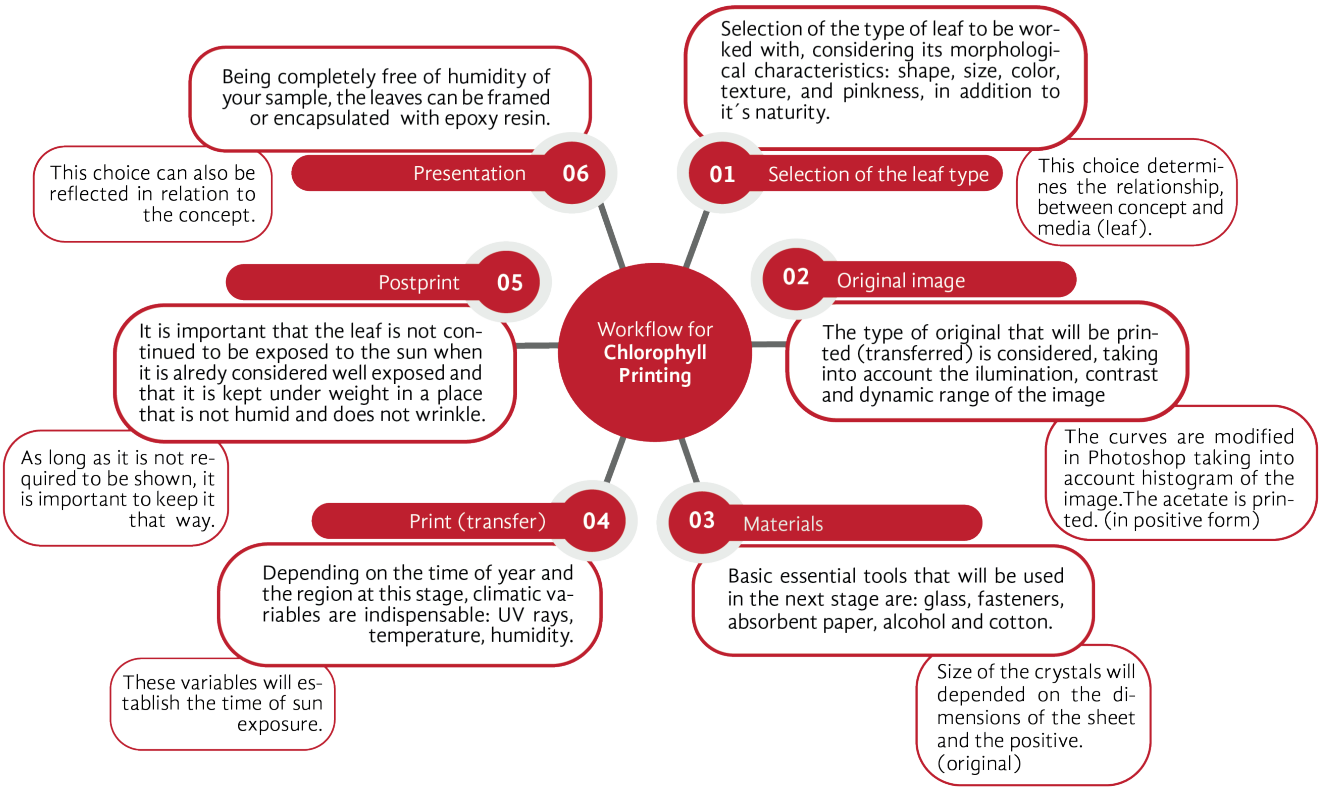

Figure 3. *Workflow for chlorophyll printing.*
Source: Elaborated by Natalia Gurieva, co-author.

Below, it could be found each of the steps to follow in detail:

1) Choice of leaf type

Physical characteristics

In nature there is a great variety of plants, therefore, it is of great importance to choose those that can adapt to the final result you want to obtain. This being so, the following characteristics can be considered: shape, size, color, texture and thickness; They are all relevant and depending on each one of them, the result may have variations.

As a matter of principle, since it is a type of contact printing, priority must be given to those leaves that are as flat as possible. Color is essential in this process, since the same type of leaf can vary in its green tones, which can cause the final print to be between yellow and brown tones. In relation to the size, this will depend primarily on the dimension of our acetate positive. For its part, the texture can give it distinctive features that are visually very attractive, even leaves that have certain damages or are dry in certain areas can work, and the result will be visually very attractive. The shape of the leaf can give it a unique visual impact, so it

 DOI: 10.32870/zcr.v8i15.223 ISSN: 2448-8437

is essential to consider this aspect. Regarding thickness, if the leaf is too thin it can result in it completely sticking to the acetate after the time of exposure to the sun. Therefore, it is recommended that it be a leaf with a density similar to a leaf of letter-size paper, that is, 0.52mm.

2) Original image

Considerations from the histogram and curve modification

When preparing the images that will serve as positives for printing, the histogram will be considered. According to Aranguen (2022), "this graphically shows the frequency distribution with which the different intensity levels (pixels) of the image appear" (p. 1). This information is of utmost importance, since, on the one hand, it determines the distribution of lights in the photograph and, on the other hand, it establishes in the aftermath the manipulation of curves for positive printing.

To know the histogram of the image, the Photoshop program will be used. To do this, open the image; Then, in the main menu, click on window and then on histogram, which will display a window where said information can be seen. In this option, the luminosity channel is selected, since we will work with the lighting, contrast and dynamic range values. Light is the most important element in capturing photographic images, since, if you do not have a correct exposure, this can end up in an overexposed or underexposed result in photographic terms. In that sense, reading the histogram becomes important, as it will allow you to know how the image is exposed. As Aranguen (2022) mentions, "if there is overexposure (high lighting), the histogram information will be loaded to the right where the light tones are located, while the information in the dark and intermediate tones will be almost null" (p. 1). With this, in photographic language, reference is made to a high-key image (see figure 4).

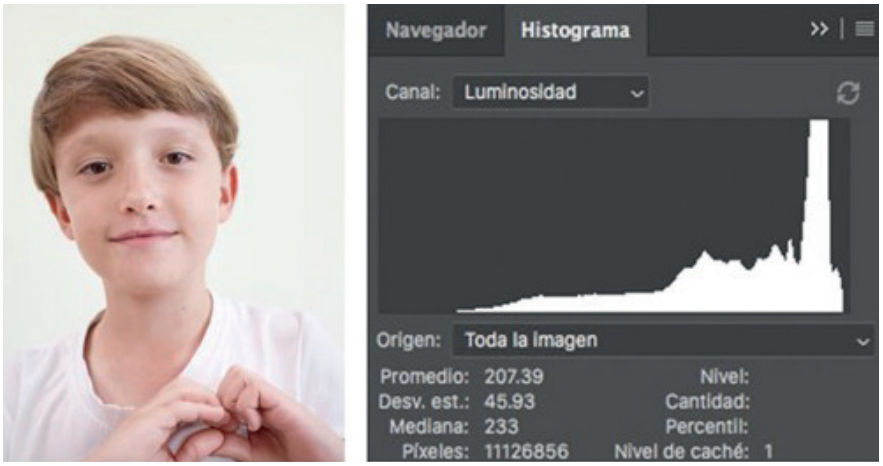

Figure 4. *High-key photographic image histogram.*
Source: Elaborated by Natalia Gurieva, co-author.

 DOI: 10.32870/zcr.v8i15.223 ISSN: 2448-8437

As for manipulating contrast, lightness, and midtones, the option in Photoshop is curves. First, the image is transformed to black and white, through the menu option, then by clicking on settings and finally to black and white. Later, in that same option, you access curves. Two points are created for image manipulation. In this regard, it is very important to take care of the lights: at the upper point, the highlights are darkened, while at the lower point detail is maintained in the shadows, as seen in figure 5, which results in a less contrast in the image and soft halftones.

Figure 5. *Manipulation of curves in high-key photography.*
Source: Elaborated by Natalia Gurieva, co-author.

Now, regarding images with decreased lighting, according to Aranguen (2022), "if there is underexposure (low lighting), the histogram information will tend to accumulate to the left, where the darkest tones are found." (p. 2), as can be seen in Figure 6, which, in photographic terms, is considered low-key.

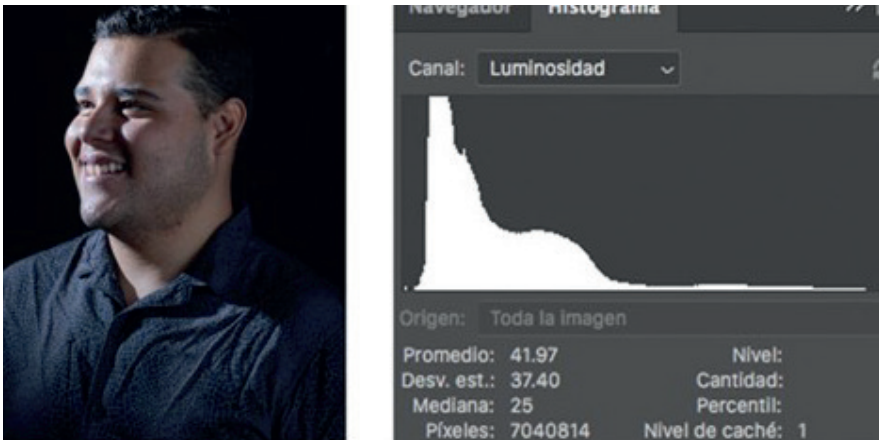

Figure 6. *Low-key photographic image histogram.*
Source: Photograph by Evert Arrañaga, own elaborated.

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To manipulate curves in this image, we manipulate it in opposite manner, that is, the shadows are raised to obtain texture and the lights are maintained (see figure 7).

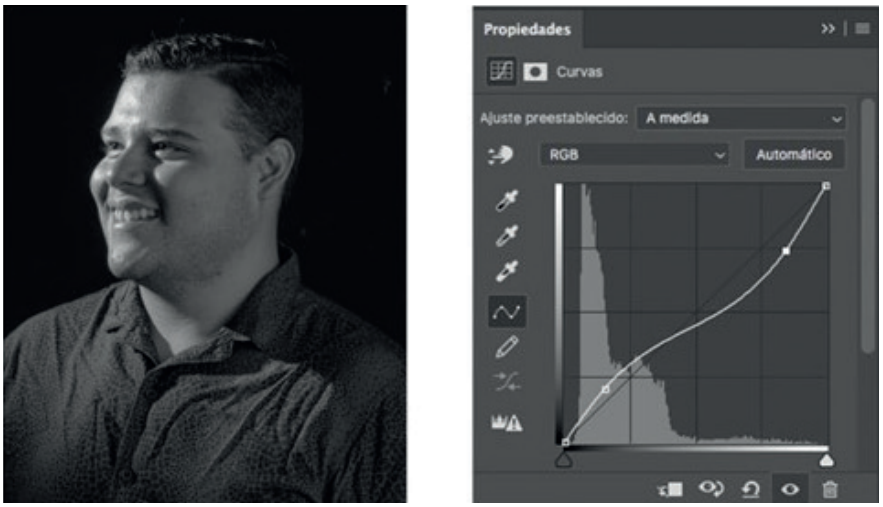

Figure 7. *Curve manipulation in low-key photography.*
Source: Photograph by Evert Arrañaga, own elaborated.

The high dynamic range, according to Aranguen (2022), "is the range of tonal difference between the lightest and darkest part of an image [...] when capturing an image, it is expected that it will present a histogram that is well distributed between the different levels of intensity" (p. 2). In figure 8 you can see this.

Figure 8. *Histogram of the photographic image with high dynamic range.*
Source: Elaborated by Natalia Gurieva, co-author.

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As you can see, there is enough information in all the lights for cornering manipulation. We proceed as follows: the first step is to reduce the contrast, recovering information in the shadows, then it is to maintain midtones and highlights, for which three points are created on the curve. The important thing is to preserve details in both lights and shadows (see figure 9).

Figure 9. *Manipulation of curves in photography with high dynamic range.*
Source: Elaborated by Natalia Gurieva, co-author.

When the curves adjustment is completed, the image is coupled with the changes that were made. Having done this, the last step is to flip the image horizontally, this is done in the editing menu, then clicking on transform and, finally, on flip horizontal, so that, when printing on the acetate, it remains on the correct side on the support and is not turned upside down. At this point, you can decide the print size for the positive, use *Transparency Film* (acetate) for laser printing.

3) Materials

Already with the printing of the images on acetate, the following materials are required:

- A pair of crystals the same size as positive
- Fasteners
- Absorbent paper
- Alcohol 96
- Cotton

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First, we proceed to cut the leaf from the stem of the plant and clean it using alcohol 96 and a piece of cotton, this to avoid any residue of dust or any external agent that prevents correct contact. Subsequently, with the pair of crystals perfectly clean, a piece of absorbent paper is placed on one of the crystals that will serve as a support (this will serve to absorb the moisture that emanates from the leaf during the process), then the leaf is placed and on top of it the acetate (the shiny part must be facing up). Then the other glass is placed and the metal fasteners at the ends are used to secure both glasses. It is very important that there is enough pressure and that they do not move (see figure 10). Finally, it is exposed to the sun's rays.

Figure 10. *Pressing the leaf and the acetate between the two glasses.*
Source: own elaborated.

4) Printing

Consideration of climatic variables and control scale

When exposing the leaf to the sun, it is essential that the following climatic variables be taken into account and considered so that an optimal impression can be created: UV rays index, temperature and humidity, as well as the season of the year. The latter given that it is a print with direct sunlight, which implies that it is advisable to carry out the process during those times of the year in which sunlight is greater.

That said, the time of exposure to the sun depends on the time of year in which the technique is carried out, in addition to considering the height of the city in which it is practiced. It is in this sense that a control scale (gray) is implemented, since, according to Osorio, Urueña and

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Vargas (2011): "A [...] grayscale is a two-dimensional matrix arrangement that provides information of the intensity of the light present for each point of the image" (p. 207) (see figure 11). In order to calculate sun exposure times, it is possible to apply transfer of the control scale on a separate leaf.

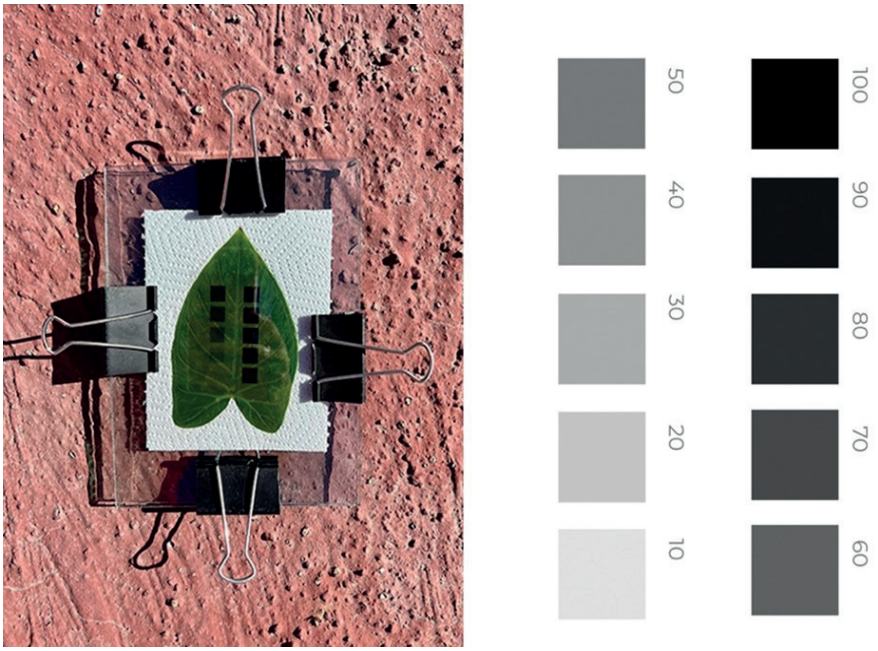

Figure 11. *Control scale application.*
Source: own elaborated.

A grayscale is a set of reference elements on a leaf that allows its quality to be evaluated in relation to the reproduction of highlights, midtones and shadows. In this case, it is possible to evaluate both different zones of the dynamic range resulting from a given combination of climatic conditions and its overall dynamic range, and make a decision on the exposure time. Since the control scale functions as an objective indicator that serves as a guide when choosing the exposure time, the results are evaluated visually or with a magnifying glass.

5) Post-print

Post-Print Care and Considerations

When removing the glass fasteners, great care must be taken to avoid damaging the leaf, as well as when detaching it from the absorbent paper. The already printed leaf can be placed on a piece of paper. It is very important not to expose it to the sun's rays and consider that it is in a state of considerable fragility. It is essential to protect the already printed leaf in a couple of leaves of bond paper and keep it weighted.

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For this, a thick book can work. You should try to place an object of good weight, as this will prevent the leaf from creasing. After a couple of hours, the leaf should be checked, as it will continue to be wet, which will cause the bond paper leaves to also become damp. Then it will be enough to change the leaves and continue with the weight.

The resulting print will be opaque. An option so that the already dried leaf can have relative brilliance is to apply a varnish. To do this, you can prepare one with micro-crystalline wax or, failing that, beeswax, and linseed oil; The method of preparation is as follows: dissolve one portion of micro-crystalline wax in a bain-marie (until it is completely liquid) with three portions of linseed oil, mix evenly until they are integrated, place in a glass jar and leave. rest for 24 hours. The result will be a kind of cream. It is important that a light layer is applied with the thumb of the hand from the center to the outside of the leaf, after its application it is stored again in the pair of weighted bond leaves.

6) Presentation

The exhibition and conservation of the printed leaf can have several outcomes that will depend on the interests of the creator. Since the leaf is quite fragile, two options are recommended: the first, a frame where the leaf is not glued to the glass, which helps it not to be completely crushed and to maintain its volume. The other option is to encapsulate it with transparent epoxy resin, which is very suitable, since, by keeping it practically sealed, it will prevent it from being damaged by external agents, such as dust.

Experiment and discussion of results

Development of the printing process

For this workflow, three leaves were chosen that are commonly and easily accessible in the metropolitan area of Guadalajara, Jalisco, Mexico. According to information from Oralia López (2023) for the newspaper *El Informador,* "according to the National Institute of Statistics and Geography (INEGI), 68% of the state's surface has a warm subhumid climate; along the coast and central zone it is temperate subhumid, as well as in the high parts of the mountains" (p.2); This is how these plants can develop abundantly and are ideal for printing.

Four variables were considered for its selection: shape, size, color, texture and thickness. Given the different characteristics that the three chosen leaves have among themselves, they are considered appropriate to establish different results for printing with the chlorotyping technique, according to the type of original images.

The first of them is what is colloquially known as elegant or elephant ear, whose scientific name is *xanthosoma sagittifolium* and, according

 DOI: 10.32870/zcr.v8i15.223 ISSN: 2448-8437

to Croat (2003), "they are widely distributed, especially in tropical and subtropical regions [...] they are cultivated, especially for ornamental purposes" (p. 2). This is a specimen that originates from Central America and is usually shaded or semi-shaded.

The second plant that was used for this experiment is hibiscus, which belongs to the Malvaceae family and, according to Sánchez (2003), "it is made up [...] of shrubs, subshrubs and trees, with whole leaves or sometimes lobed or divided" (p. 1). In the city of Guadalajara, it is found primarily as a shrub. Table 1 details the characteristics of your choice for printing.

The third and last plant is ivy, whose scientific name is *hedera helix* and belongs to the Araliaceae family, which, according to Valcárcel (2020), "is a family of plants in which ivies are found [...] The members of this family live mainly in tropical and subtropical regions, they are a plant that, due to its characteristics, can commonly be found at ground level" (p. 1). Table 1 shows the particularities of your choice.

We worked with the photographic images that were previously described. During the process, the following variables were monitored every hour: temperature, UV rays and humidity factor. Table 1 shows the characteristics that determined their choice, as well as the days of sun exposure.

Table 1. Scheme of types of leaves and climatic variables during the printing process

Leaf type and its characteristics				
Name	Form	Size	Texture	Color
Elegant	Oval, forming two semicircles. Harmonious compositions are achieved.	Ideal for printing in different formats.	Light edges.	Intense green.
Hibiscus	Rhomboid or triangular, compositions rich in harmony can be achieved.	Leaves ideally sized for a portrait print.	Its edges are light, allowing good contact with the acetate.	They are usually found in two shades of green.
Ivy	Rhomboid, compositions with greater rigidity are achieved.	They are ideal for small images, given their dimensions.	They are totally smooth.	They are usually found in two shades of green, one more intense than the other.
Printing Weather Conditions (October 12-13, 2023) Elegant Leaf				
October 12				
Time	Temperature	Index UV	Humidity	
10:08	20 grados	5	64%	

 DOI: 10.32870/zcr.v8i15.223 ISSN: 2448-8437

11:08	22 grados	7	58%
12:08	24 grados	9	49%
13:08	25 grados	9	47%
14:08	26 grados	8	43%
15:08	27 grados	6	42%
16:08	26 grados	3	43%
17:08	25 grados	1	46%
October 13			
10:00	21 grados	6	66%
11:00	22 grados	7	62%
12:00	24 grados	9	55%
Printing climate conditions (October 28, 29 and 30, 2023) Ivy and hibiscus leaves			
October 28			
Time	Temperature	Index UV	Humidity
10:00	21 grados	5	63%
11:00	23 grados	7	56%
12:00	25 grados	9	49%
13:00	27 grados	9	44%
14:00	27 grados	8	43%
15:00	28 grados	5	40%
16:00	28 grados	3	39%
17:00	27 grados	1	40%
October 29			
Time	Temperature	Index UV	Humidity
10:00	21 grados	4	63%
11:00	23 grados	7	56%
12:00	25 grados	9	49%
13:00	27 grados	9	44%
14:00	28 grados	8	43%
15:00	28 grados	5	40%
16:00	28 grados	3	39%
17:00	27 grados	1	40%
October 30			
10:00	21 grados	5	68%
11:00	23 grados	7	60%
12:00	25 grados	9	50%

Source: own elaborated.

 DOI: 10.32870/zcr.v8i15.223 ISSN: 2448-8437

As can be seen, in the elegant leaf process, at 5:08 p.m. on October 12, 2023, the UV index. It was practically at its lowest level. The control scale was reviewed, and the printing was still not in the appropriate shades, so the leaves were removed from exposure to the sun to continue the next day (it should be noted that it is not necessary to leave the leaves overnight - early morning, since humidity could alter the process). It can be verified in table 1 that the weather conditions on October 13 were similar to the previous day.

According to the grayscale where the highlights are observed (80%, 90%, 100%), halftones (30%, 40%, 50%, 60%, 70%) and shadows (0%, 10%, 20%), the decision is made about the range of tones that is most important to the artist and the correct exposure of these paintings is prioritized on the control scale. The total time of sun exposure was 11 hours, only three extra hours of exposure were needed. Regarding the printing process, on the ivy and hibiscus leaves, the workflow was carried out from October 28 to 30, 2023, and the climatic variables were taken as described in table 1. By principle, it can be seen that these variables are very similar to those on October 12 and 13, respectively, so, according to the grayscale, the first day they were not yet in an optimal impression, which is why they were removed of sun exposure to continue the next day. For the second day, October 29, the climatic variables continued in a similar way, but the hibiscus leaves (in accordance with our grayscale) already had an adequate impression, which is why they were no longer exposed to the sun on 30th of October. The total sun exposure time of these leaves was 16 hours. On October 30th the only leaves that continued to be exposed to the sun were the ivy leaves, that was corroborated with the control scale. The total time they were exposed to the sun was 19 hours.

Results and discussion

With the results obtained, we can discuss the following:

1) Different results were obtained with the choice of the type of leaf, as described in Table 2, since, primarily due to its color and texture, the final tone varied, also considering the original photograph and its light qualities.

Table 2. Description of tone/contrast/sharpness in print results

Type of a leaf	Type of original	Print tonality	Contrast	Sharpness
Elegant	High-key	Yellow/Green	Medium	High
	Low-key	Yellow	High	High
	Dynamic range	Yellow	Medium	High

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Ivy	High-key	Yellow/Green	Medium	High
	Low-key	Dark Green	Medium	High
	Dynamic range	Dark Yellow	Medium	High
Hibiscus	High-key	Yellow/Green	High	High
	Low-key	Dark Yellow	High	High
	Dynamic range	Yellow	High	High

Source: own elaborated

2) The prior consideration of the original images, prioritizing their histogram and the manipulation of the curves, is a very important point to obtain optimal printing results, that is, the adjustment to each original, in its different luminosities: key high, low and high dynamic range, provide the ideal positive (acetate) for printing.

3) Monitoring the climatic conditions and the use of the control scale allowed us to have greater certainty to determine the time of exposure to the sun, since checking the leaves at each specific time can imply that the contact moves and that, as a result, the final print result may be affected, since the image would move.

4) As can be seen in figures 12, 13 and 14, the resulting tone varies, considering the type of original, as well as the leaf; Even so, the yellow tone predominates with its respective brilliance. The results with the highest contrast were obtained with the hibiscus leaf in the three types of photographic original. The sharpness of the prints was maintained with good results on all three leaves.

5) The use of the grayscale, which can be seen in figure 14, determined the dynamic range of the printed images, tones distributed in the highlights, midtones and shadows, which allowed having the correct exposure in both the scale, as in the final images.

Figure 12. *High-key photographic image printing results.*
Source: own elaborated.

Figure 13. *Low-key photographic image printing results.*
Source: own elaborated.

Figure 14. *High dynamic range photographic image printing results.*
Source: own elaborated.

Figure 15. *Printing results of the different control scales.*
Source: own elaborated.

 DOI: 10.32870/zcr.v8i15.223 ISSN: 2448-8437

6) It is important to note the time in which the leaves were placed in the sun, this was from 10:00 am, when the UV index was at a moderate level, and from there it increased until reaching a very high point, which in this case was 9. It is considered that the gradual increase in UV index improves the printing process, that is, the photosynthesis process that each leaf undergoes influences the result of the final print.

Conclusions

The systematization of the chlorophyll printing process consisted of including different types of plants, considering the physical characteristics described above. Color and texture play a primary role, as do the photographic originals, while their prior treatment, considering the histogram and the manipulation of the curves, define the quality of the lights and, with it, the acetate print. Attention to climatic conditions is essential for monitoring, in addition to the development of a control scale, which results in an ideal exposure. The particular technique proposed can also be applied to any type of graphic information: illustration, painting, typesetting or graphic design.

As can be seen in the results, some of the leaves have certain imperfections, as is the case of the elegant leaf and hibiscus prints with the original in low-key. This circumstance, beyond being considered unfortunate, is appreciated as valuable, if the recognition of the characteristics of each plant is considered, with the understanding that they are peculiar and unrepeatable, since no leaf is the same as another, even when they are found. on the same floor. This means that the artist can, from the moment of choosing the leaf, reflect on these aspects so that his proposal is reinforced, not only in a good printing technique, but also discursively, which can add aspects that help him. to better support your creative discourse.

Each of the leaves used for this experiment has a different texture, as can be seen on its surface. Some have a greater presence than others, for example. It is important to consider this, since, depending on the theme of the original image, the texture can give different readings to the viewer.

On the other hand, sun exposure times for printing may vary, depending on the climatic conditions of the territory and the season of the year where the technique is going to be carried out. This means that the probability of a result in less time would occur in spring-summer, while for autumn-winter the times would be longer.

With all mentioned above, the objective of the work is achieved by systematizing the workflow of chlorophyll printing. This process is conditioned by the type of leaf, color and texture of the same, considering the histogram of the original image and the subsequent manipulation of

the curves for printing on acetate, it is also influenced by the verification and attention of the variables climatic factors, such as: the ultraviolet ray index, humidity and temperature, as well as the control scale, which allows greater certainty in sun exposure times.

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