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ABSTRACT

The article starts from the discussion about the change in consumer culture and popularity of

handmade, which occurred in 2020 during the pandemic. The study focuses on the resurgence of manual techniques and the use of tie-dye textile processing as a fashion trend. The general objective is to describe the tie-dye technique, explored in the context of natural dyeing, and to develop natural pigments for artisanal textile processing. The article is divided into two parts: the first presents a bibliographic research on sustainable processes, dyeing and organic fiber of cotton, while the second part describes an exploratory research on the processes of textile processing using the tie-dye technique with natural plant extracts.

Keywords: Textile processing, Handmade, Natural dyeing, Tie-dye, Organic cotton.

1 INTRODUCTION

The word "tendency" derives from the Latin term "tendentia," which means "to tend to," "to be inclined by," or "to be attracted to." The word was adapted into the Romantic languages and incorporated into Latin and European vocabularies with the sense of "inclination" or "attraction". The etymology of the word indicates that only in the eighteenth century it began to be used in France with the characteristics that define it to this day. The trends point out directions of choices or tastes that influence the marketing and sale of products (CALDAS, 2006).

Penn (2008) points out that behavioral microtrends evolve from societal movements into emerging trends that shape the future. The small subgroups show that individual choices in this era can bring contradictory tendencies. Small forces of change shape society irreversibly, creating a world without borders thanks to globalization. This makes behavioral analysis necessary to understand the technological and lifestyle changes we are currently experiencing.

It is perceived that society reorganizes its desires from phenomena that occur. The attack on the World Trade Center towers in NYC on September 11, 2001, was one of those events that triggered change. According to Penn (2008) and Gwilt (2014), one of the trends that grew from that moment was the "handmade", driven by the memories and emotional values associated with the practice of knitting passed down from generation to generation. Penn (2008) states that in recent years, there has been an exponential growth of young knitters, who see this activity as something quiet and even a type of game in which one has to go through phases to finish a piece. This movement

influenced brands such as Nike, which began to offer do-it-yourself products with custom colors and fabrics. With the possibility of customizing products, a new market in fashion opens.

Such changes mirror how society reorganizes itself in certain situations imposed by specific needs. In the year 2020 we saw that due to the worldwide COVID-19 pandemic, changes in ways of life characterized by social distancing were necessary. This statement is based on the study presented by Mattedi et al. (2020) entitled "Epidemic and containment: emerging post-Covid-19 scenarios", in which they state "[...] a social event such as Covid-19 in general and Social Distancing in particular affect both what individuals do, but also the social conditions in which they do so" (MATTEDI et. al., 2020, p.286).

This question serves as a basis for rethinking the stimuli and behavioral changes of society that influence the phenomena that occur in the world. Lipovetsky (2011, p.114) points out that "[...] consumers adopt strictly identical behaviors, typical of a global style," due to the fact that we live in a world with fewer barriers thanks to digital platforms and interactions. From this perspective, Elle (2020) reported an increase in the search for manual techniques on the digital platform Pinterest, such as the textile processing technique "bleach tie dye", "ice tie dye" and "reverse tie dye patterns". This underscores the importance of the article's discussion of the growing search for manual knowledge and craft techniques. However, there is still a research gap when it comes to manual *tie-dye* techniques with lower environmental impact performed with pigments of natural origin on digital platforms.

The initial purpose of this research is due to cultural changes in relation to the application of domestic textile processing techniques, as well as the importance of the ease of acquisition of chemical paints for the practice of textile dyeing. The technical standard NBR-14725 of 2009 describes that, if any ingredient that contributes to the danger is an industrial secret, the supplier is exempt from informing specific details about the chemical composition of the product, but must inform the dangers associated with it for the sake of human health care. However, water-soluble chemical paints are widely found in supermarkets, physical stores and online, for low prices, and do not present detailed information about their environmental impacts resulting from improper disposal after textile processing.

The article addresses topics related to fashion trends in the textile industry, focusing on the development of garments by Jones (2011) and the adoption of more sustainable processes in the choice of raw materials with lower environmental impact, addressed by authors such as Fletcher and Grose (2011), Berlin (2012), Salcedo (2014) and Gwilt (2014). In addition, issues related to dyeing technology are explored based on technical references from authors such as Chataignier (2006), Salem (2010) and Pezzolo (2013).

2 THEORETICAL REFERENCE

Jones (2011) points out that color in fashion is one of the first stages developed by the textile industries and changes every season with new tones that arise from trends and studies. For this, different pigment intensities and light resistance can affect the color according to lighting or environmental conditions. In fashion collections, the seasons of the year are considered, for example, the physical aspects of the color that influence the choice of more vivid and dark colors for the winter, which help to retain heat, while pastel, white and light tones reflect light and heat in the summer.

Color is an important issue for consumers as it reflects fashion trends in a season (FLETCHER; GROSE, 2011). However, the environmental impacts related to textile production, including the coloring and stamping of fabrics, are a major problem for the ecosystem today. Therefore, research on new technologies and more sustainable forms are highlighted in the studies of Fletcher and Grose (2011) and Berlin (2012).

Fletcher and Grose (2011, p.37) point out that the factors that make a product more ecologically sustainable can be influenced by the choice of its color, as it brings up the questions about "[...] the type of fiber, the dye, the auxiliary chemicals, the method of application, the type and age of the machinery, and the hardness of the water, among many others." However, in recent years, the authors warn that specific colors, such as bright blue and flag green, require heavy metals for their production, which are highly toxic to the environment. On the other hand, dark colors have a low exhaustion rate. "Exhaustion is important because the higher the dyeing rate, the lower the level of dye chemicals released into wastewater and the lower the risk of pollution." (FLETCHER; GROSE, 2011, p.38).

According to Berlin (2012), textile production and its production chain are responsible for a large amount of pollution, which can be proven through studies and research that point to the environmental degradation caused by this type of production. The author also addresses that water turns out to be the main resource impacted by the improper disposal of liquid waste from industry or domestic use. There are already laws that prohibit the use of some textile processing processes and their chemicals, such as those based on Benzidine, highly carcinogenic and until 2001, used in the manufacture of dyes in the textile sector.

According to Salcedo (2014), the processes of cleaning fibers, primary, secondary and tertiary processing use a large amount of chemicals, which can affect the health of people and the environment, especially when there is improper disposal of these chemicals.

Jones (2011, p.136) points out that since the 90s, the chemical industry began to address the great environmental damages caused by textile processing, resulting in more natural formulas and the return of soft colors and raw tones. However, it is important to note that there are different types of

pigments that have different affinities with fibers. It is necessary to use correct chemical mixtures so that certain tones are achieved in some fibers. Salem (2010) classifies dyes by their chemical structure into major subgroups, such as nitrophenol, nitrophosphophenol, azo, triphenylmethane, anthraquinone, phthalocyanin, vinylsulfonic, pyrimidine, triazine, among others. In table 1 it is possible to understand the type of fiber and which main type of dye possible for use.

Table 1: Classification of dyes by application.

Dyes	THE	WHE RE	S	LIK E	CT	AN D TH E	WEI GHT	PAC
Direct	X	(X)	X	---	---	(X)	---	---
Reactive	X	(X)	X	---	---	(X)	---	---
Sulphur	X	---	---	---	---	---	---	---
Azóico	X	---	---	---	---	---	---	---
The ink	X	---	---	---	---	---	---	---
Leuco esters	X	---	---	---	---	---	---	---
Basic	N	N	N	N	N	N	N	N
Cationic	---	---	---	---	---	---	---	X
Acids	---	X	X	---	---	X	---	---
Metal complexes	---	X	X	---	---	X	---	---
Chromium	---	X	---	---	---	X	---	---
Scattered	---	---	---	X	X	(X)	X	(X)
Pigments	X	---	---	---	---	---	---	---

X= Applied; (X) = Limited assortment. Applied with restrictions on solidity or affinity; N= not recommended for textiles (poor soundness). Source: Adapted from Salem (2010, p.46)

According to Salcedo (2014, p.28), "the textile industry is responsible for 20% of water contamination in the set of all industrial activity on the planet." Dyeing can be done by dyes or pigments, divided into chemical classes (SENAI, 2015). The reactive dyes used for cotton fibers have low absorption rates, around 65%, while bifunctional reactive dyes achieve up to 95% of fixation to the fabric. In the cotton dyeing processes, salt is used to obtain greater exhaustion. For polyester fibers, dispersed dyes are used, "[...] auxiliary chemicals include dispersing agents and carriers." (FLETCHER; GROSE, 2011, p.38).

It is essential to understand the dyeing systems and affinity with the fibers because the most consumed fabrics in world production are those of synthetic origin, being the polyester in the first place, followed by the vegetable origin, cotton, and of artificial origin, viscose (SALCEDO, 2015).

For this study, it becomes relevant to make conscious choices about which raw materials to use. As cotton is the second most used fiber in the fashion industry and has a good affinity with natural

dyes of lower environmental impact, it is important to understand what criteria make this fiber a more sustainable option for the application of the *tie-dye technique*.

2.1 DIVERSITY OF NATURAL AND SYNTHETIC DYES

In history, there are records of colors used in textile fibers of natural vegetable or animal origin since 2600 a. C. in China. The color of the clothes indicated social position and distinction of social classes. In the Middle Ages, dyes became important because some colors were possible to produce only with plants from tropical and subtropical countries, such as indigo for shades of blue, redwood for reds and violets, and wood for yellows. In the Middle Ages, there were about 16 colors. In the second half of the seventeenth century, the French discovered the secret of the most resistant and brightly colored Turkish red, which expanded to countries such as Holland, England, Switzerland and Germany and led European countries to better develop the technology of dyeing with plant- and animal-based dyes by the middle of the nineteenth century. At that time, the shades of the dyes varied between 80 and 120 colors, and in the eighteenth century, this number increased to 30 thousand nuances originated from 36 shades (PEZZOLO, 2013).

Synthetic dyes have been around since 1856, when the first color was developed by accident in a laboratory. Perkin was trying to "[...] synthesizing a malaria drug from coal tar, but ended up creating a purple dye, malvinea." Prior to this discovery, the color purple was obtained from marine molluscs, and industrial-scale reproduction was only possible after Perkin's discovery. (PEZZOLO, 2013, p.180). After this discovery, other synthetic dyes emerged as a consequence of the demand from the textile industries, such as the indigo dye developed by Bayer in 1880. However, only after 20 years of studies and tests was it possible to produce the cheapest and most resistant synthetic indigo.

Chataignier (2006) states that the solidity and resistance of the dye are necessary characteristics for the dyeing to have satisfactory results. In the history of fashion, in the 1950s, the Italian seamstress Elza Schiaparelli and her partnership with plastic artists created the shocking pink dye. In the 70s and 80s, the methods of industrial washing and chemical washing changed according to the needs of new consumers. Benetton used a method called late differentiation in the launch of its collections, with bold colors and neons for ready-to-wear knitting.

In a dyeing process that uses metal complexes, "[...] The metals are absorbed by the fiber inside the dye. In this case, it is important to know the nature and percentage of the metal in the dye and its degree of depletion" (SALEM, 2010, p.286). However, most dyes are not biodegradable in conventional aerobic treatment processes of industrial sewage, and require some treatment before disposal, such as precipitation with iron salts in an alkaline medium. Still, all these issues depend on the amount of material and concentration (SALEM, 2010, p.289).

According to Pezzolo (2013), hot dyeing offers better color fixation results, because the high temperatures and the prolonged time of the bath allows a better impregnation of the color in the fibers. The affinity between the types of textile fibers, mordants, and dyes can increase with the use of chemicals such as alkaline salts, reducers, or carbon sulfides. There are also dyes that provide vivid colors without the aid of chemicals such as natural materials composed of tannins.

It is perceived that chemical dyeing emerged in the history of the textile industry by the need to obtain more colors in its collections and produce materials with higher quality of color fixation, lower cost and higher productivity. However, it is important to note that knowledge about natural dyeing techniques of lower impact for home use is also relevant.

2.2 NATURAL PAINTS AND SUSTAINABLE TEXTILE PROCESSING

One can mention the importance of caring for the ecosystem when it comes to natural dyeing, because paints need care from their obtainment, because they come from renewable natural sources, and there is also time for extraction because each plant has its seasonality (SALCEDO, 2014). To perform the extraction of dyeing matter it is necessary to extract color by immersion of the boiling plant so that it loosens its color (CHATAIGNIER, 2006; PEZZOLO, 2013).

The natural extract of the plant needs to be used next to a mordant for fixation in the tissue. The mordants come from "vegetable ash, alum, tartar, urine, rust, vinegar", but can also interfere with the coloration of the plant obtained, modifying its hue. It is also relevant to point out that each textile base reacts in different ways to each type of extract and mordant, thus giving rise to different shades in the same bath. (PEZZOLO, 2013, p.168)

The tie and die technique, *spread by tie-die originates in North Africa*, "consists of knotting, folding, wrinkling, pleating or pleating fabrics, which receive a bath of paint; the tintured parts with more or less volume of pigments, provoked differentiated results" (CHATAIGNIER, 2006, p.84).

Paints of vegetable origin can be easily obtained from organic materials from renewable sources. Seasonality and plants contribute to the colors varying according to the geographical space or time of year harvested. However, the extraction of pigment from plants requires boiling time and tests to verify which colors can be used. It is possible to obtain a wide variety of shades for the application of dyeing from the use of mordants and chemical knowledge, such as the pH of the water, cooking temperature, as well as tests carried out on the chosen textile fibers.

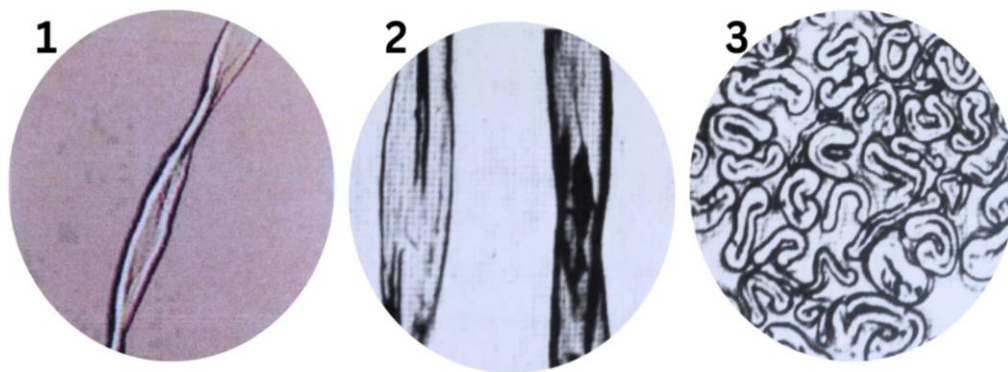
2.3 VEGETABLE RAW MATERIAL: COTTON

The cellulose fibers found in nature have in common lignin, in addition to other compounds and "[...] impurities such as gums, resins, fats, waxes, and pigments" (SALEM, 2010, p.30). When

laboratory tests are performed with the fiber it is possible to see its crystal structure with amorphous and parallel oriented regions. In their dyeing the dyes penetrate through the amorphous regions. Cotton, of the plant genus *Gossypium*, when mercerized undergoes the process of chemical treatment in caustic soda that results in the alteration of the structure of the cotton fiber and increases its affinity resistance with the dyes. (CHATAIGNIER, 2006; SALEM, 2010; SENAI, 2015).

When observing the cotton fiber under a microscope (figure 1), it is possible to notice that it has a hollow structure similar to a straw, which makes it a natural thermal insulator, retaining air inside. In addition, it has the ability to absorb moisture, especially water. This fiber is resistant to washing and the presence of alkalis, kneading less than linen. However, it is prone to attack by fungi, which can be considered a negative feature. (LOBO et al., 2014; SENAI, 2015)

Figure 1: cotton under the microscope.



In order from left to right, image 1: cotton seen with microscope; image 2: longitudinal view; Image 3: Transverse view. Source: adapted from SENAI (2015)

According to Lobo et al. (2014, p.28), cotton fiber usually presents an opaque luster, except for Egyptian cotton that has a slight luminosity due to its longer fiber, for this reason the marketing process becomes important. With a soft touch, cotton is one of the most widely used natural fibers in the fashion industry. Regarding the thermal behavior, the fiber yellows at 120°C with continuous heat, and decomposition occurs at 150°C. Above 200°C, the fiber begins to carbonize. (Lobo et al., 2014).

Organic cotton is gaining more and more popularity in the market, as pointed out by Lobo et al. (2015), due to the growing awareness of the ecological damage caused by the amount of chemicals used in conventional production. According to the authors, "the chemical load of conventional cotton production destroys the environment and causes frequent health problems for those who handle this raw fiber" (LOBO et al., 2015, p.30). On the other hand, the production of organic cotton has a low environmental impact and its goal, after harvest, is to stimulate and maintain soil fertility from a biologically diversified agricultural system. Organic cotton producers follow strict certifications and

have strict criteria for their production, which makes this raw material of high value due to the additional costs at each step of the process.

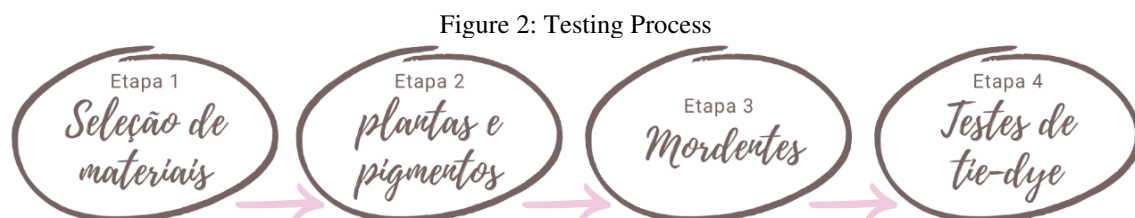
Salcedo (2014) points out that there is ecological cotton produced and certified according to the criteria of organic agriculture, such as biodiversity and soil fertility conserved; reducing the use of water in planting; care not to pollute the effluents; lower use of mineral fertilizers; lower greenhouse gas emissions; rural communities with better living and health conditions for farmers and their families; food security thanks to crop rotation.

Cotton is a raw material with pleasant thermal characteristics and easy acquisition, making it a good option for the study in question. However, to reduce the environmental impact, it is possible to use organic cotton. The search for suppliers can be carried out based on criteria such as quality seals and guarantee on their agroecological planting, focusing on the lowest environmental impact, in addition to considering the involvement with cooperative agriculture.

3 RESEARCH METHODOLOGY

The research aims to carry out textile processing tests using natural vegetable dyes to perform the tie-dye technique on organic cotton fiber. In this way, the step by step for the processing is carried out taking care of the choices in the processes for a lower environmental impact, in addition to describing about the processes for the extraction of natural pigments in the realization of paints, the textile treatment , and application of the tie-dye *technique* in organic tissue.

Figure 2 shows the first step, which consists of the selection of materials for the performance of textile processing tests using natural vegetable dyes. Then the color tests are created with 3 different types of mordants: copper sulfate, iron sulfate and potassium alum. After performing the color tests, the hot *tie-dye* technique is fixed.



Source: Developed by the authors.

It is essential to follow the proposed processes for carrying out tests in each of the stages of the treatment of textiles. The choice of ready-made extracts accelerates the dyeing process, eliminating the stage of extracting pigments from plants and allowing greater focus on the pre- and post-processing steps for textile coloring.

4 ANALYSIS

According to Gwilt's (2014) approach to sustainable development of fashion products, the selection of materials considered the ethical impacts, including the organic cotton of Justa Trama, a Brazilian company that works with cooperatives and has a complete production chain, from the cultivation of agroecological cotton to the production of textiles and final pieces, with the knitting production headquarters in Porto Alegre. Justa Trama is certified by IBD for organic cotton (JUSTA TRAMA, s/d). The extracts used were provided by the company Etno Botânica, which focuses on the research of native Brazilian dye plants and their different extraction processes. Etno Botânica also follows criteria of ecological agriculture or sustainable forest management throughout its production chain (ETNOBOTANICA, s/d). In 2017, the author of the article, Perini, held a training in Itamonte, MG, to improve the handling and application of the techniques used.

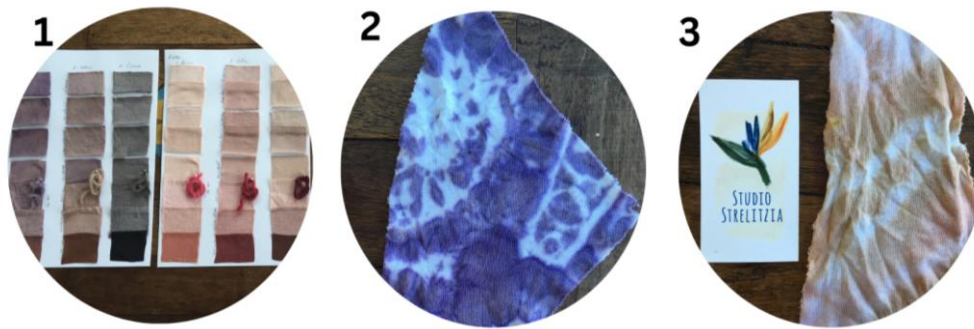
In the creation of the color chart for the tests, we used organic cotton as a base in twill, tricoline and sweatshirt, in addition to making the samples also in linen, hemp, silk and wool. The extracts used are Raíz Rúbia for the shades of pink and Pau-Campeche for the shades of violet.

In Figure 3 you can see the tests of materials and colors developed, and also the *tie-dye tests*. The uses of dispersed dyes were followed by the authors Lobo et al. (2015, p.105) which describe that "[...] are applied in the form of aqueous dispersions or colloidal suspensions that form solid solutions with the fibers." These fibers do not contain acid or basic groups for the fixation of direct dyes, and end up being sensitive to hydrolysis in alkaline conditions of the vat bath¹. During the dyeing techniques the "[...] originally insoluble form is slowly precipitated into dispersed form on cellulose acetate [...]" (LOBO et al., 2015, p.105). The authors also point out that the dispersed dyes have some limitations such as insufficient resistance to washing, and gas bleaching due to atmospheric ozone.

For the *tie-dye tests*, a circular sweatshirt mesh base made of organic cotton was selected. Single colors were used to evaluate tincture fixation, while color mixtures were used to evaluate color migration in the samples.

¹ VAT dyes can be used for the dyeing bath, that is, by immersion of fabrics in aqueous dye solutions and for printing, mainly in the form of pastes. (BR 112014010454-9 B1, 2012, p.18)

Figure 3: Testing Process



In order from left to right, image 1 color chart using different mordants, image 2 tie-dye in one color, image 3 tie-dye with two colors.

Source: Developed by the authors.

After the selection of suppliers, with the performance of the tests on the selected raw material, the cotton purging step was included. According to Lobo et al. (2014), purging is important to improve the hydrophilicity of the fiber, preparing it for later dyeing. This process is part of the cleaning of the fibers, with the removal of oils and fats present in the natural fibers.

To perform the purge, it is necessary to start with the weight of the dry piece, in order to calculate the amount of water and the amount of neutral soap without whitener. Thus, the calculation is made every 100 g of fabric, and 1 liter of water and 20 ml of neutral soap are used. The water temperature should be up to 70°C and the process time is 15 minutes, stirring all the time. After purging just wash the piece in running water.

The process of pre-mordant with potassium alum results in bright and clean colors (Ferreira, 2005). For every 100g of dry tissue, it is recommended to use 2 liters of water and 150g of potassium alum. The exposure time is 30 minutes, with constant agitation, and the water temperature can reach up to 70°C.

To carry out the tie-dye *dyeing process*, the wet piece with mordant must be kneaded and tied to protect the areas that will not be dyed (as shown in image 3 of figure 4). Next, it is necessary to dilute the extracts in hot water at a temperature of 70°C, thus creating the paints to be applied on both sides of the piece.

After the dye is ready, the piece should be placed in a steam environment, we use pots with lids and a sieve, so that the piece does not touch the water for 30 minutes on each side, as well as in the eco-print technique. Finally, with the piece still tied, the fixing step is made with coarse salt. The piece is immersed in a warm bath of 30°C and, after the temperature drops, it is possible to untie it and open it under running water. At the end of the process, you can wash the piece with neutral soap and dry the shade.

Figure 4: Testing Process



In order from left to right: image 1: piece of organic cotton for weighing; image 2: pre-mordant; Image 3: Mooring process; Image 4: Application of paints; Image 5: Drying in the shade; Image 6: Fashion editorial. Source: Developed by the authors.

The tie-dye *dyeing technique* was developed with the purpose of spreading knowledge about more sustainable techniques following the trend of the *handmade movement*. Gwilt (2014) highlights that sharing fashion ideas related to do-it-yourself manual techniques strengthens the sustainable market and contributes to making fashion more accessible, taking into account the conscious use of available resources.

5 FINAL CONSIDERATIONS

Based on the arguments presented in the research and the tests carried out on materials and processes, it is critical to address sustainable and environmental impact issues for the general public. Currently, consumer behavior trends have presented a change in the consumer public, which often becomes more judicious in its choices. In the information age, do-it-yourself has become commonplace, but care must be taken when sharing information about chemical and natural dyeing processes. It is perceived that understanding the composition of textiles and their form of planting goes beyond understanding their use in a final piece, as it involves greater criteria on the environmental impacts with the use of pesticides, the use of water and CO₂ emission.

As far as natural extracts are concerned, it is possible to obtain them manually from plants, seeds, leaves and bark of trees or fruits, but it is important to remember that care is needed when sharing information about natural dyeing processes and their environmental impacts. To disseminate this information more widely, it becomes relevant to expand this type of research beyond academia and include it in open information-sharing platforms. It is perceived that this information should

include criteria for the choice of materials and care in extraction, in order to ensure environmental sustainability.

Although handmade manual techniques are freely available on various social media, there is still a gap regarding information relevant to the public. It is essential to offer information on the sustainability of the reuse of fabrics, the use of raw materials with less environmental impact, such as organic cotton, and also on the environmental impacts of the techniques carried out with domestic chemical processes or in the choice of responsible suppliers. In the study it was possible to realize that it is possible to effectively apply the *tie-dye* technique in organic cotton using natural paints, in addition to bringing updated knowledge of how to make an ancestral technique with current technologies. In addition, in the next studies it is important to describe how to carry out the correct treatment of effluents and the proper disposal of waste generated during the textile processing techniques developed.

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