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作品名稱 Ecological inks for markers

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就讀學校 Centro de Bachillerato Tecnológico  
Industrial y de Servicios No. 271

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## 作者照片



## **Abstract**

*Markers have become essential in school and work life due to their great usefulness for teaching and homework. Despite the benefits they have brought, markers are the cause of great contamination from the ink manufacturing process to the excessive production of plastic. Ecological inks in markers and the innovative design of a refillable marker, allow to generate less pollution without having to stop using this product.*

*From dyes created with coffee, fruits and vegetables that pass through different processes, natural inks arise that replace the use of polluting dyes. Likewise, implementing recycling plans in different institutions, markers that were no longer used were collected to be filled with ecological inks and used again. In addition, the excessive production of plastic is reduced by selling and refilling markers and ink kits.*

## **Introduction**

The present research was carried out with the interest of developing inks manufactured with natural ingredients to fill markers without ink and in this way reduce the excessive production of plastic and the damages generated to the environment by the ink in the markers.

Research starts from knowing the chemicals most commonly used in manufacturing ink to the type of plastic used, the time it takes to degrade and its recycling feasibility. It was essential to determine the importance of markers in schools and all the waste that this product generates. The objectives of the project revolve around extending the life of the markers and reducing their cost to benefit students and teachers who need this product in their daily activities.

The development of ecological inks and the marker refill service will help counteract the damage caused to the environment, also impacting the economic sphere by reducing costs. In the social sphere, it is expected to contribute with the donation of markers to schools in marginalized areas of Mexico. In the same way, the design of a refillable marker is a fundamental part of the project to understand how the product is composed and why all the contamination that is generated is very relevant.

## **Important concepts**

Inks: an ink can be defined as a colored liquid that is used to write or draw, using an appropriate instrument (Diccionario de la Lengua Española, 2019).

Inks composition: all inks that contain insoluble coloring parts have the particularity that a solution medium has been added, or rather suspension medium that avoids, on the one hand, the precipitation of coloring pigment and, on the other, ensures its

fixation on the paper. The whiteboard markers are based on alcohol-based solvents or alcohol-free solvents such as metaxylene and toluene (Arreola, *et al.*, 2015).

Markers: based on research carried out at the University of the Gulf of Mexico Campus Orizaba, the term marker is the one used to designate those writing instruments that can be found with inks of different colors and that generally have a thicker line. Markers are writing instruments that have their own dose of ink, which is impregnated in small sponges or felt that are placed inside the marker (Arreola, *et al.*, 2015).

Environmental pollution: environmental pollution is a phenomenon that directly and indirectly affects the health of people and alters the balance of ecosystems. In general, living beings are exposed to mixtures of more than two toxic substances. This contact with toxic pollutants can occur during processes of production, distribution or use of products such as medicines, food, cleaning products, insecticides, pesticides, industrial formulations and household items, or when they are disposed of into the environment (Revista de Ciencia, 2007).

Plastic: it can be defined as the saying of certain synthetic materials: that they can be easily molded and that they are mainly composed of polymers, such as cellulose (Diccionario de la Lengua Española, 2019).

Plastic types: there are different types of plastics and some are easier to recycle than others. For example PET (Polyethylene Terephthalate) used in plastic bottles and HDPE (High Density Polyethylene) are easy to recycle. PP (polypropylene) which is common in markers and DPE (low density polyethylene) are feasible for recycling. Finally, PVC (polyvinyl chloride) that is used in credit cards is very difficult to recycle (National Geographic, 2019).

### **Importance of markers**

The problem identified is the pollution caused by the massive production of plastic in the manufacture of markers, the few possibilities that exist for recycling it and the damage that ink causes in the environment. In the same way, the high prices of the markers affect the economy of students and teachers by having to purchase the product periodically.

Surveys were carried out in the school Centro de Bachillerato Tecnológico Industrial y de Servicios No. 271 (CBTis 271). The results showed that the use of markers has become essential for students and teachers. It was obtained that the interviewed teachers invest money monthly in the purchase of white board markers that are used to teach their class. The results gave a broader perspective of how many markers are discarded per semester and that end up in the landfill. Similarly, several students were asked about the markers they buy and it was shown that it is an essential product in their list of school supplies, buying at least one package each semester,

which means that it is a large amount of wasted markers since almost no one reuses them at the beginning of the next school year.

It is estimated that around the planet some 5.7 billion tons of plastic waste do not pass through a recycling plant (National geographic, 2018). In fact, each year around 8 million tons of this waste end up in the sea (National Geographic, 2019). The material with which markers are generally made is polypropylene, which takes approximately 500 years to degrade (Vidal, 2008). This type of plastic is feasible to recycle (National Geographic, 2019), however, there are few places where markers are collected for recycling.

In Mexico, the price of markers varies from \$100 to \$800 MXN or even more (Amazon, 2021). And the markers that are used regularly have chemical components that are often not friendly to the environment and can become toxic to marine life like zebra fish (Álvarez, *et al.*, 2015).

Taking into account the damage caused by plastic and ink to the environment, in addition to the economic expense generated by this product, it is inferred that through this project a solution is given to the problems described above and the entire community benefits, mainly students and teachers.

The proposal to solve the problem is to use natural inks made with coffee, fruits and vegetables that replace toxic and polluting chemicals. The filling of recycled markers, the design of a refillable marker, a sustainable business model and recycling plans in different institutions provide a solution to the excessive production of plastic.

## **Objectives**

General purpose: extend the life of markers by filling them with eco-friendly inks made from natural pigments.

Specific objectives:

- Manufacture ecological inks based on coffee, fruits and vegetables such as: beets, carrots, spinach, etc.
- Design an innovative and sustainable refillable marker.
- Implement recycling campaigns in various institutions to collect markers that are no longer used.

## **Methodology**

The development of the project consists of different stages for its implementation and experimentation with fruits and vegetables from the region. The process begins with the identification of an existing problem in educational establishments where different types of markers are used. CBTis 271 students and teachers were observed to constantly dispose of inkless markers causing contamination to the subsoil and

damaging marine life. In addition, the teaching staff has to invest money monthly in the purchase of this product.

That is why there is a need to develop a product that is capable of meeting the needs of the school and work environment while taking care of the environment since conventional markers bring many disadvantages such as pollution and high prices.

An experimental methodology was used for the development of the inks, experimenting with different vegetables. Research on natural colorants began, determining that the vegetables with which we would begin the experimentation would be chard, beets, carrots and coffee. The most viable ways to obtain natural colorants were obtained:

- Brown color: natural or instant ground coffee is mixed with water or alcohol to obtain different shades of brown.
- Red color: beets are dehydrated and subsequently liquefied to obtain a mixture between purple and red colors, the mixture is strained and to obtain the ink we add water or alcohol. We strain again and the coloring will be finished. Another alternative is the use of hibiscus flower or red peppers.
- Orange color: the same procedure is repeated with carrot. Another alternative is to use orange bell peppers or orange peel. This color is hard to obtain directly, it is better to mix red and yellow.
- Green color: The ingredient is ground, be it chard, spinach, coriander, among others, adding warm water and then passing through the strainer. This color is hard to obtain directly, it is better to mix blue and yellow.
- Yellow color: Turmeric powder is mixed with water or alcohol and then strained.
- Blue color: Purple cabbage is boiled and sodium bicarbonate is added. Another alternative is the use of blueberries.
- Purple color: Purple cabbage is boiled. Another alternative is the use of blackberries or mix blue and red.

The ink also requires a conservative such as sodium benzoate. In the same way, for the development of a marker, a plastic support or mold for down is needed, which will include a felt or chisel point, body of the down and cap. For the sale of ink kits, droppers and glass containers of different capacities are required.

## **Results**

Natural inks based on fruits and vegetables were developed to replace conventional inks made from chemicals that are harmful to the subsoil and marine life. Through markers recycling campaigns, it was possible to teach about the importance of take care of the planet among the students of Mexico. An agreement was reached with local businesses to establish marker collection centers.

Water and alcohol inks were achieved with a durability of one year and a refillable marker with its pieces was designed. The brand name was established as “Nature Markers.”

A lower index of contamination produced by the markers was obtained, the impact of commonly used inks towards marine life and the ocean is reduced, meanwhile, with the recycling of the marker structure, the damage of the plastic towards the sea is being reduced, thus extending the life of the marker to the maximum and preventing it from going through the industrial recycling process.

## **Discussion**

According to the results obtained, it is observed that the objectives set were met and the hypothesis was verified. With the smallest container, approximately 6 to 8 markers can be filled depending on the capacity of each one.

A future line of research is the development of a suitable bioplastic that favors markers and does not affect the environment. Likewise, it seeks to improve the inks so that they are even more durable.

## **Conclusion**

Markers are important in everyday life, however, it has been observed throughout research that their excessive production causes harm to the environment. Through the eco-friendly inks, the refillable marker design, the sale of the ink kits and recycling plans, it is possible to reduce environmental pollution, in addition to reducing costs to the consumer. It is concluded that there may be comfort in the products used every day while taking care of the planet because ecological inks and refillable markers fulfill their function in a sustainable way.

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## Attachments

Survey "Pollution caused by markers"

The following survey is carried out to determine the number of markers that are bought and discarded in a year in CBTis 271, in addition, it seeks to know the usefulness of this product for students and teachers. We appreciate your participation.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Student: yes/no Teacher: yes/no

How many markers do you use in a semester?

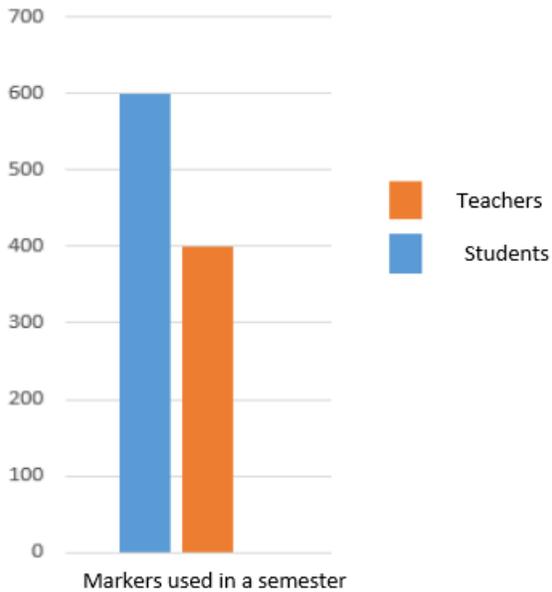
a) 0 - 7      b) 8 – 19      c) 20 – 39      d) + 40

Do you consider markers necessary in your life?

a) Yes, I do    b) No, I do not

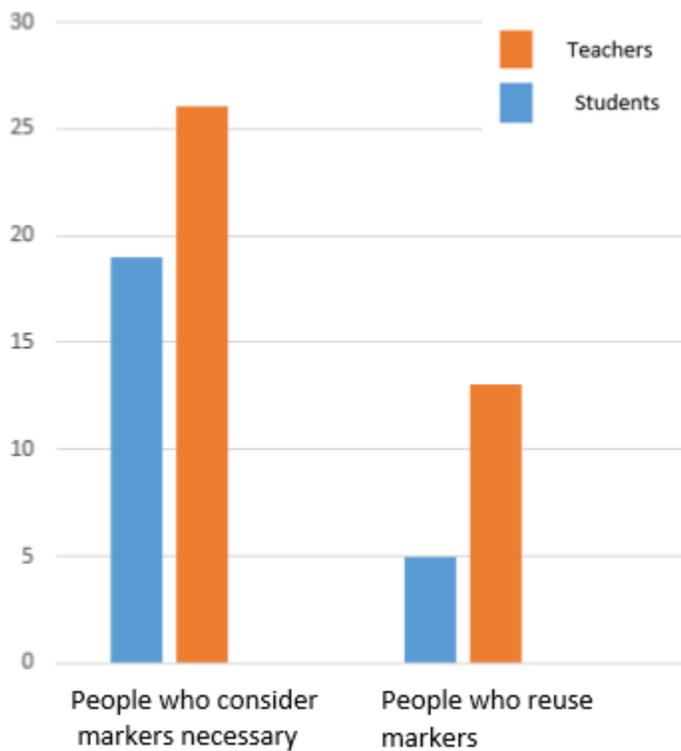
Do you reuse the markers every semester until they finish their function?

a) Yes, I do    b) No, I do not



Graphic 1. Markers used in a semester according to the survey applied in CBTis 271

In a group of 30 students the approximation was 600 markers per semester. The survey of 30 teachers resulted in 400 markers per semester.



Graphic 2. Considerations and reuse according to the survey applied in CBTis 271

19 students out of 30 considered the markers essential. 26 teachers out of 30 also considered them necessary in their life. Only 5 students out of 30 say they reuse their markers each semester and 13 out of 30 teachers.

## Markers design

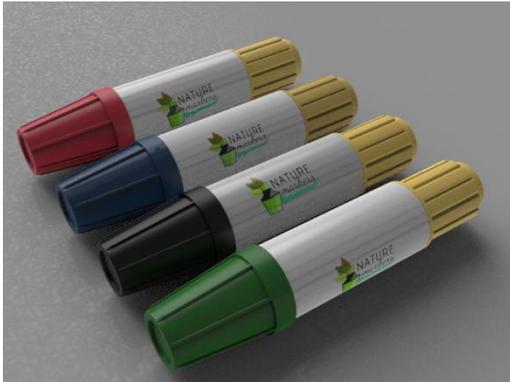


Image 1. Refillable markers.



Image 2. Blue marker design.



Image 3. Refillable marker and its pieces.

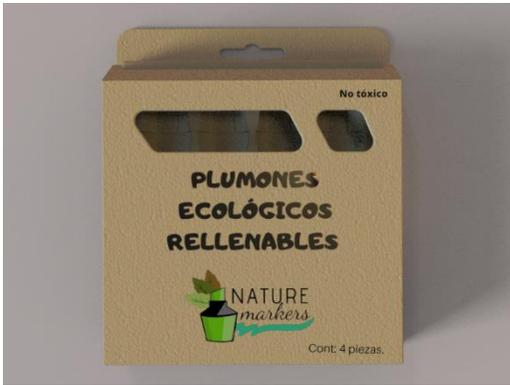


Image 4. Package design.

## Business Model Canvas

# BUSINESS MODEL CANVAS

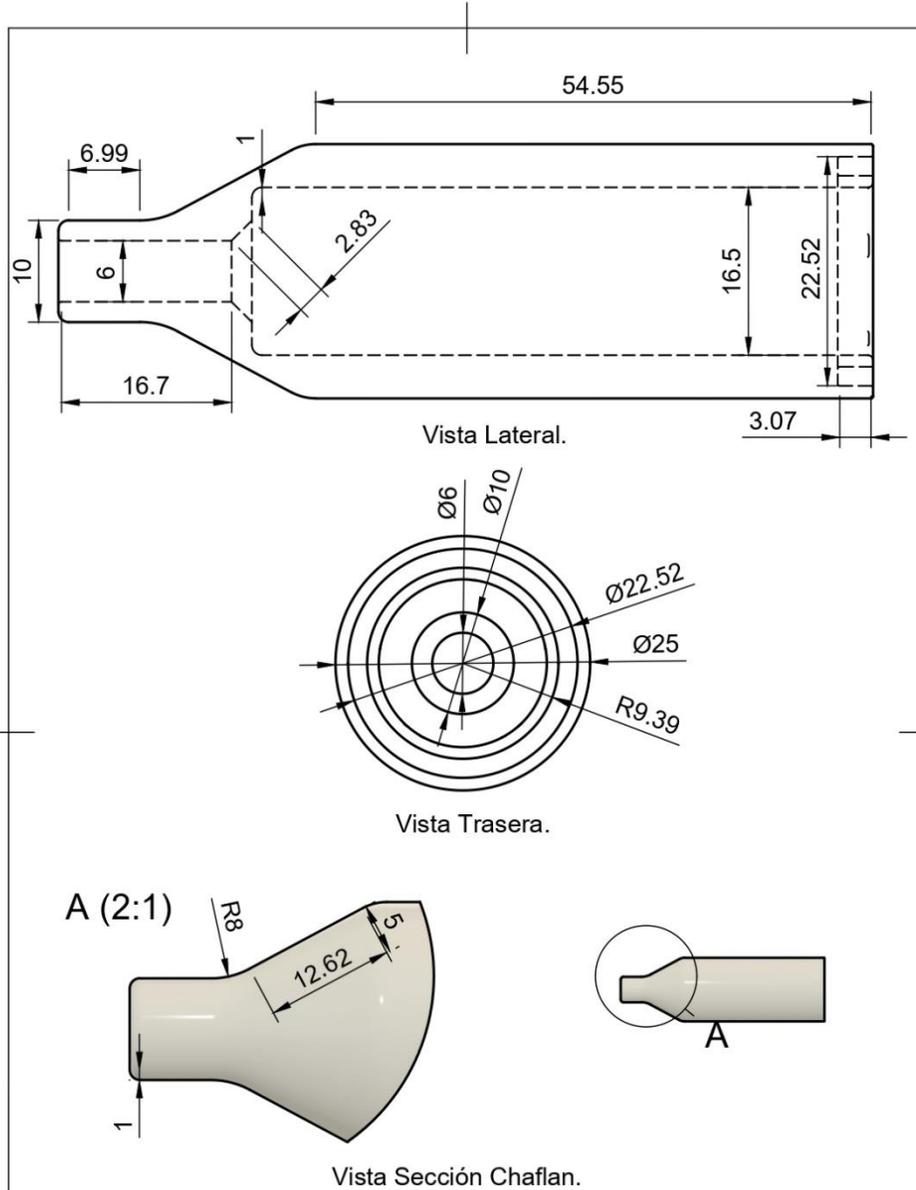
<p><b>Key Partners</b> </p> <ul style="list-style-type: none"> <li>-Schools</li> <li>-Government institutions</li> <li>-Glass distributor</li> <li>-Fruit and vegetable suppliers</li> </ul>	<p><b>Key Activities</b> </p> <p>Markers recycling Sale and filling in markers and ink kits. Production planning. Agreements with government institutions and companies.</p> <hr/> <p><b>Key Resources</b> </p> <p>Fruits and vegetables. Conservative Containers Store Machinery (blender, dehydrator, stove)</p>	<p><b>Value Propositions</b> </p> <p>Ecological inks for markers that give life to markers that have been discarded by activating local commerce.</p>	<p><b>Customer Relationships</b> </p> <ul style="list-style-type: none"> <li>-Accessible price</li> <li>-Personalized attention</li> <li>-Low prices when reusing the kit.</li> </ul> <hr/> <p><b>Channels</b> </p> <p>Social networks, triptychs, bookmarks, campaigns in schools, agreements with government institutions and local companies.</p>	<p><b>Customer Segments</b> </p> <p>Students and teachers of the different educational levels that live in Mexico and usually use markers in their daily activities.</p>
<p><b>Cost Structure</b> </p> <p>Electricity, gas, water, conservative, containers, drippers, fruits and vegetables.</p>		<p><b>Revenue Streams</b> </p> <p>The main source of income is the filling of the markers, a second alternative is the sale and refilling of ink kits. Payments will be processed in cash</p>		

Social networks to promote the "Nature Markers" project

Facebook: <https://www.facebook.com/naturemarkers>

Instagram: <https://instagram.com/naturemarkers?igshid=1djtzkollop8c>

Recycling campaign video: <https://fb.watch/2Yj2QRiYkl/>



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Image 5. Marker body.

## 【評語】 180015

The present research was carried out with developing inks manufactured with natural ingredients and could reduce the damages to the environment by the ink in the markers. The thoughts and inspiration are to be commended. But no tangible experimental products or conclusions are obtained. It need some experiments and comparison with commercial ecological markers to show its advantages and benefits. The costs and whether this design could be automated are also very important.