

Banana Paper Production

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Abstract: Paper is one of the most used elements in modern society, despite the fact that its invention dates back to ancient times. The paper is used for different domestic, labor and industrial purposes. Its manufacture is made from cellulose pulp and vegetable fibers, which have had a significant environmental impact over the years. This paper proposes the analysis of paper making from the use of banana plant residues, which could offer a better use of natural resources and a lesser impact on nature. In addition, the natural fiber of bananas is resistant and is easily obtained in Latin American countries such as Ecuador, which has a high production of this. The results found show that it is possible to make paper with fiber from banana residues and that it is possible to commercialize and make good use of resources.

Keywords: Pseudostem, paper, banana, circular economy.

Producción de papel a partir del banano

Resumen: El papel es uno de los elementos más utilizados en la sociedad moderna, a pesar de que su invención data de épocas remotas. El papel es utilizado para diferentes fines domésticos, laborales e industriales. Su fabricación se realiza a partir de pulpa celosa y fibras vegetales, que han tenido un importante impacto ambiental en los últimos años. En este trabajo se propone el análisis de la elaboración de papel a partir del uso de residuos de la planta de banano, lo que podría ofrecer una mejor utilización de los recursos naturales y un menor impacto a la naturaleza. Además, la fibra natural del banano es resistente y es de fácil obtención en países de Latinoamérica como Ecuador, quien presenta una elevada producción de este. Los resultados encontrados muestran que si es posible la elaboración de papel con fibra de residuos del banano y que es posible la comercialización y buen uso de los recursos.

Palabras Clave: Pseudotallo, papel, banano, economía circular.



I. INTRODUCTION

Currently in the Amazon every second a quantity of trees similar to the size of a soccer field is lost. This means a great impact for all the species that are part of this jungle ecosystem. The same happens in different parts of the world, as in Spain, where during 30 years approximately a quarter of the oak forests were lost. One of the industries that are largely responsible for this is the paper manufacturing industry, which produces huge amounts per year that are consumed by different countries around the world, and which yield significant pollution figures in all sectors.

The commonly used white paper requires 90% of cellulose from trees, which not only affects the vegetation, but also the environmental repercussions that this entails, since an average of 48 kilos of paper is consumed per person. One tree produces approximately 100 kilos of cellulose, which implies the felling of 3696 million trees per year [2], approximately 18 million hectares, which will not only cause environmental problems in the jungles and forests, but will also have an impact on rainfall and other environmental conditions.

The use of banana residue for paper production can be an important advance in environmental conservation. Latin American regions are high banana producing regions. Ecuador, due to its geographical location, is fortunate for its fertile and suitable land for banana production [3], achieving an average production of six million metric tons with a profitability of two and a half million dollars.

In the Ecuadorian territory there is an average of one hundred and sixty-two thousand hectares of banana plantations which produce rachis, which is the waste of the banana plant [3]. For this reason, and taking into account that the paper producing sector is not only important economically but also environmentally, the use of this waste represents a way to preserve the Ecuadorian environment.

By mentioning Ecuador as a country of agricultural activities, it is possible to obtain a series of advantages that can be generated to give a better incentive to this economy. These activities are usually like harvesting the fruits of the plants that grow on the Ecuadorian coast. The crops that stand out the most in this region of the country are commonly banana crops. The task that farmers perform is to cultivate and harvest, and then sell them, so when they do this work, they generate waste from the plants [4]. The farmers are not aware of how to make the best use of the residues, so they can be reused to obtain other by-products for food or paper manufacturing.

On the other hand, it is worth identifying the negative aspects associated with paper production, since several organizations have determined that the use of chlorine bleaching agents or toxic chemicals, which often cause air and water pollution, persists [3]. On the part of the customers, this introduction of new products is a bit strange, since people have become accustomed to the consumption of normal paper, which most of them do not like the change or this new product, innovation while a small part of consumers agree with the preservation of resources such as banana pseudostems [4].

In this work, the production costs of paper and its environmental impact are analyzed, and contrasted with the high demand it has with respect to the market, due to the participation of people to meet the different needs [5]. However, the cost of paper production has increased due to the different raw materials used for its production, being more environmentally friendly and healthier for people. Nowadays, paper recycling is very important to avoid future overexploitation of resources that will be suffered by future generations [3].

Likewise, a sustainable production of paper based on banana will prove to be more beneficial to reduce the stress on forest resources, the high degree of cultivation and consumption in recent times has become the second largest fruit crop in the world [6]. In addition, the main banana producers are China, the Philippines, India and Ecuador, where in Ecuador they are trying to obtain organic paper from banana stems, thus saving the felling of trees that are currently in excess. This is why the innovation in Ecuador in the production of paper has brought other countries to implement a new product to the market that generates greater added value for consumers and the company as such.

For the creation of the paper, two methodologies will be used. The first one seeks a dark brown paper with a rough texture, while in the second one more soaking time is applied prior to cooking, obtaining a medium beige paper with a finer texture. Similarly, the high acceptance of paper in the market is a clearer way for people to adapt to the change of a new product and what it would mean at a global level for it to become a daily consumption [5]. For this reason, an environmental culture should be promoted with the manufacture of organic paper by the different organizations that know that they are in a latent change with respect to products such as paper. Currently there is a growing trend towards the use of ecological products or products that promote sustainable development. On the other hand, paper as such does not have a substitute product, which is why paper made from banana pseudostems has a high potential demand. In addition, it should be taken into account that in Ecuador paper is imported from Canada, Chile, Brazil and the U.S., so that being a local product can also help reduce import costs. The import of tree pulp in Ecuador has a 12%

tax, which would be another cost that would be reduced with this product.

This work consists of four parts where we will explain this process that will help us to protect the environment, in the introduction we will talk about the current situation, the use of white paper and the raw material that we will use, in the second part that we will have for development will allow us to appreciate and know the production process of alternative paper, we will continue with a third part in which the conclusions will be observed, to finish with the bibliography that makes reference to the material used to be able to expose this topic.

II. DEVELOPMENT

Paper has existed since ancient times, its use was present in the year 200 BC [2], but it was in the 17th century when paper was handmade, but its use was not as great as the present, which allowed an environmental balance. Later on, its use grew, leading industries to improve their production processes in order to increase sales, but without considering the environmental repercussions.

Since the 1660's, due to the evolutions that have been generated within the technology, which have determined another type of methodologies regarding the production of paper ensuring a better quality, as well as the increase of the demand by the society adopted that tool in their daily life. It is when the appearance of obtaining paper based on vegetable fiber occurs, which has led to the deterioration of the ecosystem due to the existing deforestation, since approximately 15 reams of paper are obtained from a trunk, which shows that the felling of trees at a great level of increase [6].

Currently, there has been a certain awareness on the part of human beings who have sought ways to innovate and achieve a better sustainable development, with this has generated the idea of paper recycling, in order to promote another use and reach that efficiency with respect to excessive consumption of wood. A major problem according to traditional paper mills is the large amount of excess of polluting waste, since now the use of bleaching agents such as chemicals and also the non-incorporation of non-degradable material [7].

According to the responsibility of each person for the development of products that are not harmful to the ecosystem, there is a need to achieve a synergy between the environment and the human being. This is how the proposal for the development of paper based on the waste generated by banana producers, a fruit that is grown in Ecuador. The use of banana as raw material for paper is crucial in order to achieve a care towards the environment and therefore the determination of another technique that can effectively help with respect to the preservation of the ecosystem [3].

A. Paper elaboration process

There are 2 types of processes for the elaboration of organic paper, on the one hand the brown color and on the other hand the beige tonality with different cooking times, in the first instance there is a cooking time of 120 minutes or 2 hours, the second time is 2 hours 0 minutes and the last one is approximately 3 hours [6].

1. Peeling: In this first step for paper making, the rigid outer part that envelops the fiber is removed from the banana stems.

2. Chopping of the pseudo stems: As a second step, the pseudostem fiber raw material is cut into small pieces of approximately 1-3 cm each piece.

3. Cooking: The previously cut pieces are placed in a container to then take them to the place where the cooking is going to be carried out, in the fire is boiled at 120 minutes, in addition a second sample of 150 minutes and up to a third sample of 180 minutes is carried out [6].

4. Liquefying of the fiber: As the next point it is left to drain for 1-2 minutes and subsequently liquefied with water so that the fibers are crushed correctly and passed through the strainer as many times as necessary, once the pulp is obtained, the fibers are washed until the water dries completely [6]. Once again it is drained again and a container is placed to proceed to distribute it in the mold.

5. Drying: As a last step we proceed to the drying part which should be done in a shade, in a place that is in contact with the air for 2 or 3 days to obtain the organic paper.

To make the other process of organic paper only varies by an additional step that this has for the color tone of the

paper that can be detailed as follows:

1. **Peeling:** In this first step in papermaking, the rigid outer part that envelops the fiber is removed from the banana stems.

2. **Chopping of the pseudo stems:** As a second step the raw material of the pseudocalli fiber of approximately 1-3 cm each piece is chopped into small pieces.

3. **Soaking:** The pieces or chunks that were previously collected are placed in a container and allowed to soak for 24 hours.

4. **Cooking:** The previously cut pieces are placed in a container and then taken to the place where the cooking is going to be done, in the fire is boiled for 120 minutes, in addition a second sample of 150 minutes is done and up to a third sample of 180 minutes.

5. **Liquefying of the fiber:** As the next smear it is left to drain for 1-2 minutes and subsequently liquefied with water so that the fibers are crushed correctly and passed through the strainer as many times as necessary, once the pulp is obtained, the fibers are washed until the water dries completely. Once again it is drained again and a container is placed to proceed to distribute it in the mold [6].

6. **Drying:** The drying is done in the shade, in a clear place for two or three days to obtain the organic paper and proceed to use it for various designs and a unique and different finish [6].

It is worth mentioning the above mentioned about how paper can be treated and elaborated through banana fiber. Now, the question that stands out most in this research is: Is it possible to maintain a positive impact for companies engaged in this activity with respect to their economy and the environment? The answer is of course. One of the factors that should be included is that the responsible and sustainable use of banana plants will generate impacts not only for the environment and the economy of the companies, but also for society and scientists [4]. Within these guidelines of positive impacts, one could begin by mentioning the impact on society. Responsible use will generate economic resources for the banana sectors of the country and neighboring countries. Since paper production has a high and constant demand over time, it will generate more jobs in order to avoid the use of wood trees that are massively used for the production of conventional paper. This will not only help companies dedicated to paper production, but also farmers who have a large amount of this resource, but due to lack of knowledge it is not used efficiently. Another impact that can be projected for the sustainable use of banana waste is that farmers will be able to benefit from a higher percentage of income. That is, the owners of the banana plantations, when selling the products of the plants, obtain income from sales, then after the cycle of the plant reaches the end of its life cycle, it will no longer be left to dry on the ground to serve as fertilizer, but will be able to access constant economic benefits for the paper companies. Given this, it opens multiple paths to the research sector, because it can be derived to multiple facets to add new knowledge for new products or more sustainable uses that are not currently known. In addition to being able to guarantee new ideas for the creation of industrial technology, in order to cover the correct use of banana residues, thus helping to eliminate the use of trees for the manufacture of paper and affecting the life of the forests.

B. Economic and Social Impact

Through the production of banana-based paper, the company seeks to create a socially responsible enterprise. In this sense, through this production process, we intend to support the local communities where the company is located. Initially, this will be done by collaborating with small banana producers, who will be the main suppliers of raw material that will allow the production process to be carried out. This is intended to generate a new income for these people. In addition, the people who will collect the banana peels will also be part of the community, thus generating new sources of employment. On the other hand, for the productive part, the company will also seek to have personnel from this area, which will be achieved through an extensive training process. It is of utmost importance that the company considers the social aspect, since within the business philosophy it is not intended to profit from others, but to generate a collaborative economy, a business model where services are considered a means of exchange, so that all interested parties can benefit.

On the other hand, it is of utmost importance to highlight that the quality of life of the community would improve significantly with this product, since the waste generated by the banana will not remain in the plantations, thus reducing the decomposition of the waste and radically reducing the risk of pests and therefore diseases. This project not only seeks to generate an environmentally positive alternative, but also to generate an option for economic growth in sectors that have not always been sufficiently considered. In a developing country such as Ecuador, it is important to create this type of growth opportunities from the smallest to the largest categories, so that power groups cannot monopolize the national market.

III. METHODOLOGY

The paper manufacturing process identifies that initially the wood must be obtained from the forests, which is transported by truck to the factory to extract the bark and the bark, then it is cut into small pieces, those pieces or chips are submerged at high temperatures in a mixture of water and some chemicals, sulfites and caustic soda in order to separate the wood fibers and thus obtain the cellulose pulp (Fig.1).

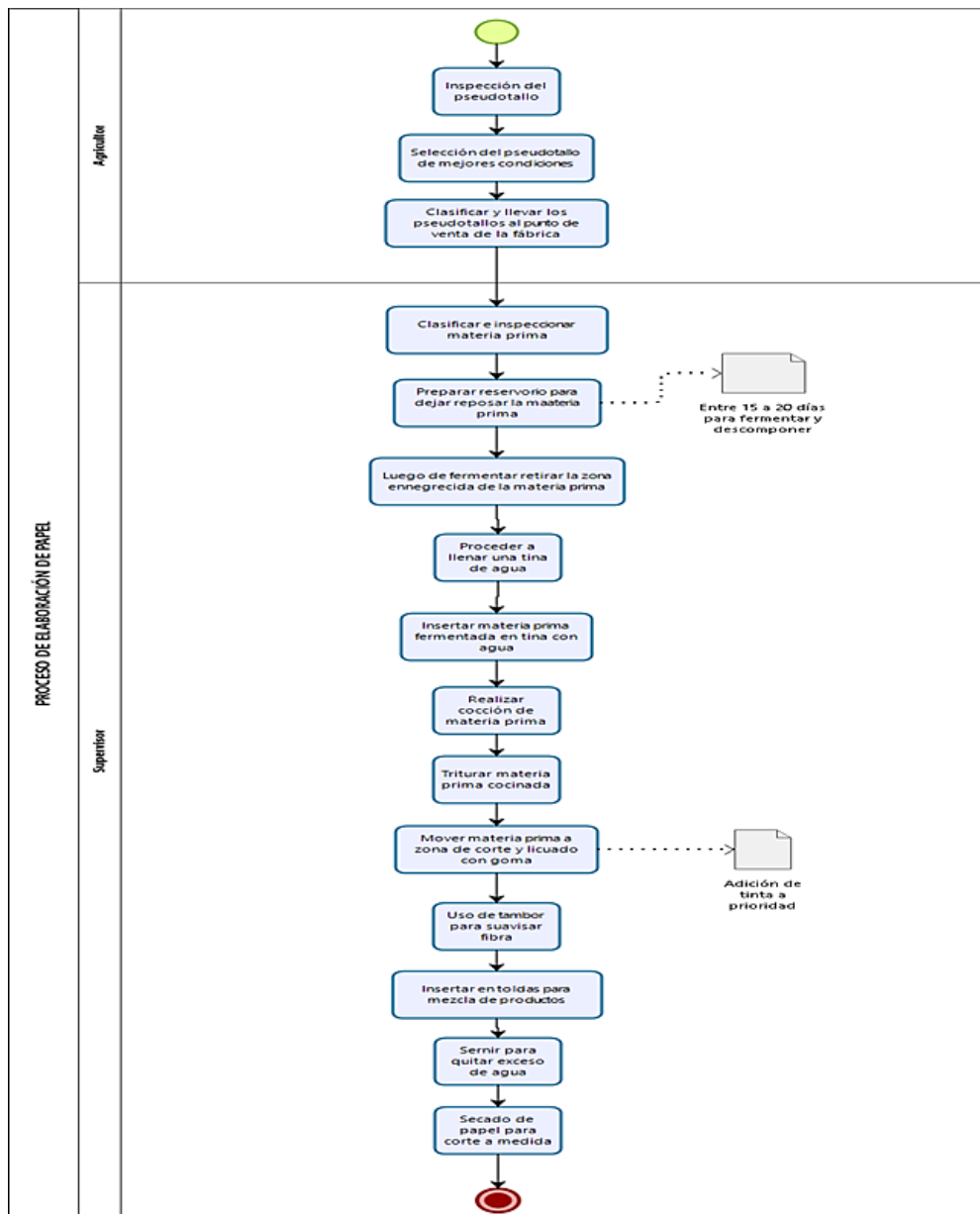


Fig. 1. Paper manufacturing process

After this process, the cellulose pulp is taken to the drums to apply other types of chemicals to bleach it, some of these are chlorine dioxide, oxygen, caustic soda and peroxide, with all this is to remove all the lignin not removed in the cooking. Thus, the pulp is placed on metallic meshes, where the paper takes shape while it dries and releases water, likewise, regulations are taken on the pulp according to the density, consistency and flow rate and it is placed on a flat table to build the sheet. Afterwards, the desired thickness of the paper is obtained by passing through rotating rollers where a mark can be printed. The paper is then pressed on rollers that are coated with felts to extract more water and a few more rollers to ensure texture, then a final phase of heated rollers to ensure drying and finally the surface treatment with cold rollers to give the paper a glossy finish.

The process to manufacture one ton of paper requires the felling of 17 trees, which implies a significant environmental impact, taking into account that one tree in one day provides enough oxygen for three people.

It should be noted that from all the waste generated by the banana cultivation process, paper can be obtained not only from the pseudo stems of the plant, but also from the banana stalks. Currently, banana waste generates pollution because it does not have an appropriate use; however, if the use of the waste for paper production is considered, two environmental situations could be solved at the same time. However, Ecuador is in a very complex situation with respect to the world in terms of using resources in a sustainable and responsible manner. Although initiatives have been taken on the subject, a much broader and responsible development is still lacking. The international environmental organization Greenpeace revealed that for any country to choose to focus on paper production and cover such a demanding market [3], it will be necessary to build for years two pulp mills similar to one already built by Botnia in Uruguay, which produces one million tons of bleached eucalyptus pulp per year.

A study by the Center for Technology Transfer and Agroindustrial Research (CETTIA) of the Universidad Técnica Particular de Loja, in Ecuador, has revealed that an optimal process for the production of paper from banana peel begins with the transportation of the rachis to the factory. When the raw material arrives at the company, the rachis (banana residue) is peeled and then taken to cylinders to separate the core from the trunk. The objective is to transform it into a pulp in order to separate the fibers (cellulose). Once the pulp is obtained, the process to follow is to place the fibers in aqueous suspensions between 4 and 12 gr/l with the intention of handling the dry fibers. This will generate the lamination of the pulp, with this, it will be possible to physically suspend the friction process to increase the capacity of the process, this is considered the refining. With this, the paper will finally be obtained.

IV.RESULTS

Once the analysis of the following work has been carried out, it is possible to establish the following results: The two types of organic paper processes based on banana pseudostem, the times that are delayed due to their cooking processes, consist of 120 minutes to obtain a dark brown color, with a time of 150 minutes the color is medium brown and with a duration of 180 minutes a shade of brown color was achieved. Likewise, each stage of the process plays a fundamental role so that the finished product is optimal and the resources are used in the best possible way.

On the other hand, when contrasting process 1 with process 2 in relation to the times, significant changes were observed between them, the colors obtained were sand tone, camel tone and a medium beige tone, due to the fact that the raw material was subjected to a soaking process. Similarly, the texture obtained is usually rigid, medium fine and fine, which is why organic paper has a clear acceptance in the market, because consumers have been inclined towards more environmentally friendly products, satisfying the growing demand for paper through its fibers and banana pseudostem.

On the other hand, and taking into account the commercial aspect, it has been shown that during the year 2020, in order to supply the demand for white paper, it is necessary to build two plants per year capable of producing approximately one million tons of bleached eucalyptus pulp. This is undoubtedly a shocking figure in comparison with the environmentally friendly process proposed in this work. Figure 2 describes the possible supply chain for paper production.

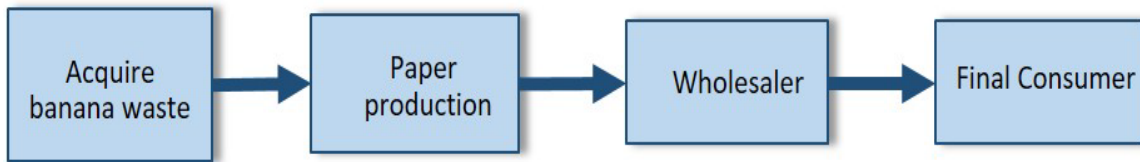


Fig. 2. Supply chain for paper production

Finally, this process provides vitality to the environment and has a focus on the circular economy, which is conceived as the use of resources, reducing the input of materials and aiming to complete the full cycle of an ecological flow, ensuring sustainability and influencing the reduction of waste, in this case, ensuring a more environmentally friendly paper.

V.CONCLUSIONS

A.This work allows us to learn about a new process that despite its great potential has not been implemented in society and this allows us to see it as a possible project for banana producing countries as a future source of income and environmental care.

B.Although the production costs of banana paper are higher compared to the cellulose that comes from the felling of trees, alternatives could be found to reduce costs and thus make it more attractive to the final consumer.

C.As an alternative proposal at the country level, this could be thought of as a process in collaboration with the state to avoid deforestation and be subsidized in the following way part by the state in order to control the erosion of places that are affected by indiscriminate logging.

D.The impact that this new process generates does not affect society only from the environmental point of view, but also allows us to dynamize a new commercial and industrial opportunity, becoming a change in the structure of thought of all the people who are part of the process, generating awareness and a new way of seeing the world. This new process may in the future be a reference to become a change in the productive matrix for banana producing countries.

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