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MANUFACTURE OF PAPER USING THE CELLULOSE PROVIDED BY THE SARGASSUM

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Abstract: The sargassum problem in the Mexican Caribbean has become an environmental and economic crisis. The excessive proliferation of this seaweed affects tourism, fishing and pollutes beaches. The proposal of this work consists of transforming this problem into an opportunity, using sargassum as raw material for paper production. Because it is rich in cellulose, sargassum can replace wood pulp in the manufacture of paper, thus reducing the felling of trees and reducing the environmental impact of the paper industry. The proposed process involves collecting the sargassum from the sea by means of conveyor belts, avoiding damage to the beaches. The seaweed is then shredded and subjected to a washing and cellulose extraction process. The paper obtained could be marketed to paper companies, offering a more sustainable and economical alternative. The benefits of this project are multiple: Reduction of environmental impact: Reduces tree felling, reduces beach pollution and takes advantage of a resource that is currently a problem. Generation of economic benefits: Creates new business opportunities and reduces production costs for paper companies. Solution to an environmental problem: Helps control the proliferation of sargassum and improves water quality and the marine ecosystem.
Keywords: Sargassum, paper, collection, treatment, logging.

INTRODUCTION

The proliferation of sargassum in the Mexican Caribbean has become a recurrent phenomenon due to factors such as the increase in ocean temperature and other climatic changes. Studies carried out by the Interdisciplinary Center of Marine Sciences and the Biological Sciences Division of the National Polytechnic Institute describe sargassum as a floating mass in constant movement. Although the tourism sector considers it a coastal pollution problem,

scientific research has revealed the potential of this algae for various uses, which opens new economic perspectives. In Mexico, research on sargassum has focused on understanding the causes, seasonality and distribution of the species involved, with special attention to the regions of Cancun and Puerto Morelos, where upwelling has been particularly abundant and diverse.

METHODOLOGY OR DEVELOPMENT

Castillo Arenas and Dreckmamm (2013) conducted a study in Punta Cancun and Puerto Morelos with the objective of determining the taxonomic composition of sargassum. The results indicated the presence of 40 different species, of which 25 were large and potentially exploitable. However, most of the species (22) had a seasonal distribution, while only 15 were perennial. The genus Sargassum proved to be the most abundant, representing more than 80% of the dry weight of the collected samples, as shown in Figure 1.

Figure 1.- Floating Sargassum

Source: https://agendasettingdiario.com/

Sargassum arrivals in Punta Cancun and Puerto Morelos present a seasonal pattern, with peaks of abundance during the months of July-August and October-November, coinciding with the rainy season and tropical cyclones. These events have generated an urgent need to implement management strategies and use of sargassum. However, the cleaning brigades of the Federal Maritime Terrestrial Zone lack adequate infrastructure to deal with the large quantities of biomass that arrive at the coasts. Official data from the Ministry of Ecology and Environment of Quintana Roo reveal the magnitude of the problem, with a representative example from July 2015, where more than 28,000 tons of wet sargassum were collected in a single week, with Benito Juarez being the most affected municipality. See fig. 2

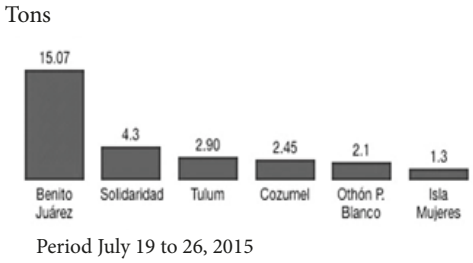

Figure 2.- Wet Sargassum removed in Quintana Roo.

SOURCE: El Universal, August 2015.

The increase in the amount of sargassum has been increasing year after year (see Fig. 3), so it is necessary to implement actions that are now a problem in solutions to climate change, this initiative aims to reduce the felling of trees and thus contribute our bit for the protection of the environment.

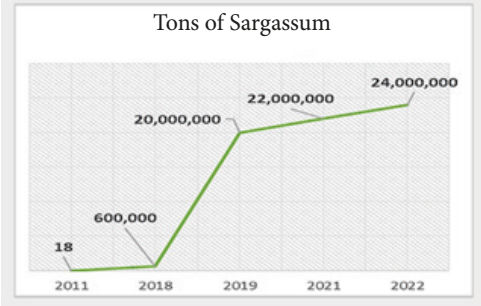

Figure 3.- Increase of sargassum in tons from 2011 to 2022.

SOURCE: Dianco Mexico.

OPERATION PROCESS

The main activities will be harvesting and processing. Some laboratory tests will be carried out in order to demonstrate the effectiveness of this compound as a substitute for wood cellulose.

At the same time, the operating costs and expenses for each of the activities and their profitability will be evaluated, using different methods such as rates of return and cash flows over time, among others.

COLLECTION

The collection process will be used to obtain the raw material for further processing.

Factors to consider for the adequate extraction of sargassum for which it is necessary to consider several factors, such as:

- Season of the year
- Collection methods
- Quantity collected
- Feasibility
- Costs
- Impacts for the area
- Storage

SARGASSUM CONVERSION

For the second stage of this project, the extraction of cellulose from the sargassum will be sought in order to use it as raw material for the production of paper as described at the beginning, only wood will be substituted as raw material.

It is necessary to emphasize that harvesting is the most important stage, since it is where most problems are encountered.

SARGASSUM DRYING

The seaweed drying options considered are:

1. By air drying
2. By means of special furnaces

Open air drying consists in the use of solar energy as the main source of heat, this process can be carried out through the use of solar collectors, which are devices that consist of:

- Solar dryers consist of a dark metal surface, usually black, oriented towards the sun to maximize the absorption of solar radiation.
- The heat generated is transferred to the surrounding air. This surface is covered by a transparent material, such as glass or plastic, which allows sunlight to pass through but prevents heat loss.
- In some large capacity models, an auxiliary heating system, using fuel or electric power, is incorporated to ensure continuous operation in conditions of low solar radiation or during the night.
- On a larger scale, specialized greenhouses provide a controlled space for algae cultivation and drying, allowing larger quantities of biomass to be stored.

CELLULOSE COMPOSITION

"Ascensión Sanz Tejedor states in her paper (https://www.eii.uva.es/organica/qoi/tema-03.php) that cellulose is the most abundant natural organic compound. According to the author, this polymer is the fundamental component of the cell wall of plants, wood and natural fibers, and is usually found combined with substances such as lignin and hemicelluloses. Tejedor points out that cellulose is a linear polymer formed by glucose units, whose chains are linked by hydrogen bonds. He also points out that due to the variable nature of cellulose chains, it is difficult to determine an exact molecular

weight. However, values ranging from 50,000 to 2,500,000 umas, which is equivalent to 300-15,000 glucose units, have been reported.").

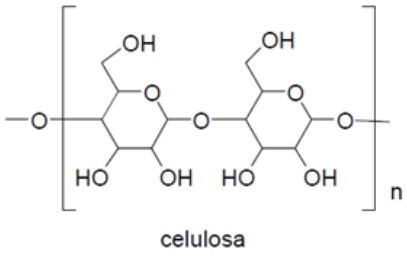

Figure 4,- cellulose composition, Ascensión Sanz Tejedor, https://www.eii.uva.es/organica/qoi/.

The paper industry is the main consumer of cellulose. The combination of long and short fiber cellulose, in different proportions, makes it possible to obtain a wide range of papers, with more than 450 varieties available on the market. At the microscopic level, the cellulose fibers in paper form a network interconnected by hydrogen bonds. World production of paper and cardboard is approximately 300 million tons per year, mainly for the manufacture of packaging (43%), printing materials (30%), newsprint (12%) and hygiene products (15%).

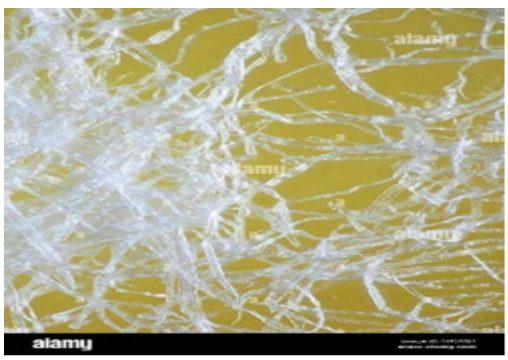

Figure 5.- Cellulose fibers
(photographs and high-resolution images-Alamy)

CELLULOSE LABORATORY MANUFACTURING PROCESS

For one gram of dry sample, 15 ml of 80% acetic acid and 1.5 ml of concentrated nitric acid were added and subjected to reflux for 20 minutes, the residue was filtered, washed with ethanol, dried in the oven at 100-105°C and weighed, then incinerated at 540°C, which forms a paste that will be subjected to the following process for the manufacture of paper:

- **Sheet formation:** The cellulose pulp is deposited on moving metal screens. As the pulp dries and releases water, the paper sheet is gradually formed. The residual water, which still contains cellulose fibers, is collected for further processing.
- **Smoothing and pressing:** Once the sheet is formed, it passes through rotating rollers that give it the desired thickness. Subsequently, it undergoes a pressing process between felt-covered rollers to remove excess water.
- **Drying:** Before final drying, the paper passes through various mechanisms such as dewatering rolls, foils and suction boxes, which help to eliminate residual water. It then undergoes a pressing process to consolidate the sheet and, finally, it is dried by means of hot cylinders.
- **Surface treatment:** After drying, the paper is passed through cold rollers to give it a final finish and characteristic gloss. In some cases, a coat of stucco is applied to improve printability and dimensional stability.

SUMMARY OF THE PROCESS

The papermaking process involves the formation of a sheet from an aqueous suspension of cellulose fibers, followed by a process of water removal, smoothing, drying and surface finishing. Each stage of the process contributes to the final properties of the paper, such as thickness, texture, smoothness and strength.

A special roller, known as a gate roll, an improved version of traditional rollers, is used to apply a layer of stucco to the paper during the manufacturing process. Another common technique is the use of the bill blade, which uses a knife and roller to apply the stucco more precisely. After the stucco is applied, the paper passes through a series of overlapping metal rollers that regulate its thickness without altering its gloss. It is then wound onto large spools by a device called a pope, and sent to the finishing area to receive additional treatments, such as a more elaborate stucco or a simple surface finish.

CONCLUSION

Sargassum, a marine algae that has proliferated along the coasts of the Mexican Caribbean in recent years, has become an environmental and economic problem for the region. This study proposes an innovative solution: the use of sargassum as a raw material for paper production.

Sargassum has a high cellulose content, similar to that of trees, which makes it ideal for paper manufacturing. In addition, its processing requires less aggressive chemical treatment than that used for wood cellulose. The use of sargassum as a raw material for paper production offers several advantages:

-Reduces environmental impact: Reduces the felling of trees and the use of potable water and energy associated with traditional paper production.

-Use of an abundant resource: Turns sargassum, which currently represents an environmental problem, into a valuable resource.

-Generates economic benefits: Creates new business and employment opportunities in the region.

The study proposes a sargassum collection and processing system that minimizes the environmental impact on the beaches. In addition, the study proposes marketing the paper produced to paper manufacturing companies, seeking to reduce their environmental impact and production costs.

In short, the use of sargassum as raw material for paper production is presented as a viable and sustainable alternative for the management of this algae in the Mexican Caribbean, generating both economic and environmental benefits for the region.

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