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# SUSTAINABLE SIPPING: EXPLORING THE VIABILITY OF *COCOS NUCIFERA* L. LEAVES STRAW

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## ABSTRACT

Coconut trees are abundant in tropical regions, and their leaves are often considered as agricultural waste. However, these leaves have fibrous characteristics that could be utilized as a potential resource. This research paper explores the use of coconut leaf straw as a sustainable alternative material. The paper examines the material properties and the process of extracting and using coconut leaf straw. It provides insights into the mechanical, chemical, and environmental attributes of this natural resource. The findings offer a foundation for further research and development into utilizing coconut leaf straw as a sustainable material. The goal is to present coconut leaf straw as a viable alternative to traditional materials, reducing waste and promoting sustainability. By understanding the unique properties of this abundant natural resource, new applications and uses can be explored, contributing to an eco-friendlier future.

**Keywords:** Coconut, Sustainable Alternative, Coconut Leaf Straw, Eco-Friendly, Natural Resource.

## I. INTRODUCTION

Over 300 types of plastics are produced, with 60 being the most popular. Single-use plastics (SUPs) account for 50% of global plastic production and account for 360 million metric tons in 2018. However, most SUPs are disposed of in landfills or incinerated, causing resource loss and environmental damage. This article provides an overview of global SUP production and highlights actions to reduce its impact. Over 300 varieties of plastics are manufactured, with about 60 being the most widely used. The classification of plastics can be based on their intended use and with general plastics and engineering plastics (Yuan, 2009).

There are currently 75–199 million tons of plastic garbage in the ocean, and according to the UN Environment Programme's (UNEP) most recent study, From Pollution to Solution, 9–14 tons of rubbish entered the aquatic ecosystem in 2016. This is expected to have almost quadrupled to 23–37 million tons annually by 2040. Comprising at least 85% of all marine debris and plastics, they are the most prevalent, hazardous, and long-lasting type of marine litter.

**Fig 1:** Plastic pollution in ocean

Coconut leaf straws are a sustainable and renewable alternative to plastic straws, offering biodegradability, strength, durability, and aesthetic appeal. They are biodegradable, compostable, and surpass bamboo straws in sustainability. They are also chemical, ensuring pure and untainted drinks. They are versatile and can accommodate various drink types, making them ideal for cocktails, smoothies, and refreshing drinks. The production of coconut leaf straws often involves local communities, contributing to economic prosperity, and reducing carbon footprints. They are cost-effective and widely accessible, making them a cost-effective choice

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for eco-conscious consumers. Despite initial costs, the long-term environmental impact of plastic straws outweighs initial savings, making coconut leaf straws a cost-effective and environmentally friendly alternative.

**Taxonomic classification of Coconut:**

Kingdom: Plantae

Phylum: Magnoliophyta

Class: Liliopsida

Subclass: Arecidae

Order: Arecales

Family: Arecaceae

Genus: *Cocos*

Species: *nucifera*

**Scientific name: *Cocos nucifera* L.**

English professor Saji Varghese has created an eco-friendly product made from coconut leaves, Sunbird Straws, which costs Rs 3 per straw and has received over 20 million straws since its launch in 2017. Sunbird Straws is safe for use on skin, eyes, and infants. Varghese's company, "Blessing Palms," encourages environmentally beneficial inventions and produces straws made of rice, tapioca starch, wheat, bajra hay, bamboo, glass, PLA paper & edible flavour.

## II. MATERIALS & METHODOLOGY

**Materials:**

1. Coconut leaves
2. Knife or scissors
3. Ruler
4. Twine or thin rope (optional and for tying)
5. Normal water for washing the leaf
6. Straw making machine
7. Binding agent: Potato Starch & Gum Arabic

An environmentally friendly substitute for plastic straws is to make straws out of coconut leaves. This is a straightforward method for creating coconut leaf straws:

Choose the semi-dried coconut leaves and clean them with regular water. After cleaning, soak the leaves in regular water for 30 minutes, then sterilize them by boiling them in water for 5 minutes or soaking them in regular water for 5 minutes. Use a ruler to measure and mark the desired length of your straws on the coconut leaves. Typically, straws are around 20–25 cm (8–10 inches) long, but you can adjust the length as needed.

Cautiously cut along the marked lines using a sharp blade or scissors. Make sure the cuts are straight and clean to create uniform straws. After cutting, you'll have long coconut leaf strips. Apply the potato starch and gum arabic to the leaf. Tightly roll each strip to form a cylindrical shape, similar to a traditional straw. You may need to adjust the tightness to achieve the desired thickness.

If you'd like, you can tie the ends of the coconut leaf straws with some twine or thin rope to keep them from coming apart. Spread the coconut leaf straws out on a well-ventilated tray and let them dry in a shaded area. You can give them a quick spray if you want; this will help get rid of extra moisture and make the straws more durable. Before using, thoroughly rinse the coconut leaf straws with clean water to remove any dirt or debris. The best part is that coconut leaf straws are biodegradable, so you can compost them or get rid of them in an eco-friendly way when you're done.

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**Flow chart of the process of making a coconut straw:**

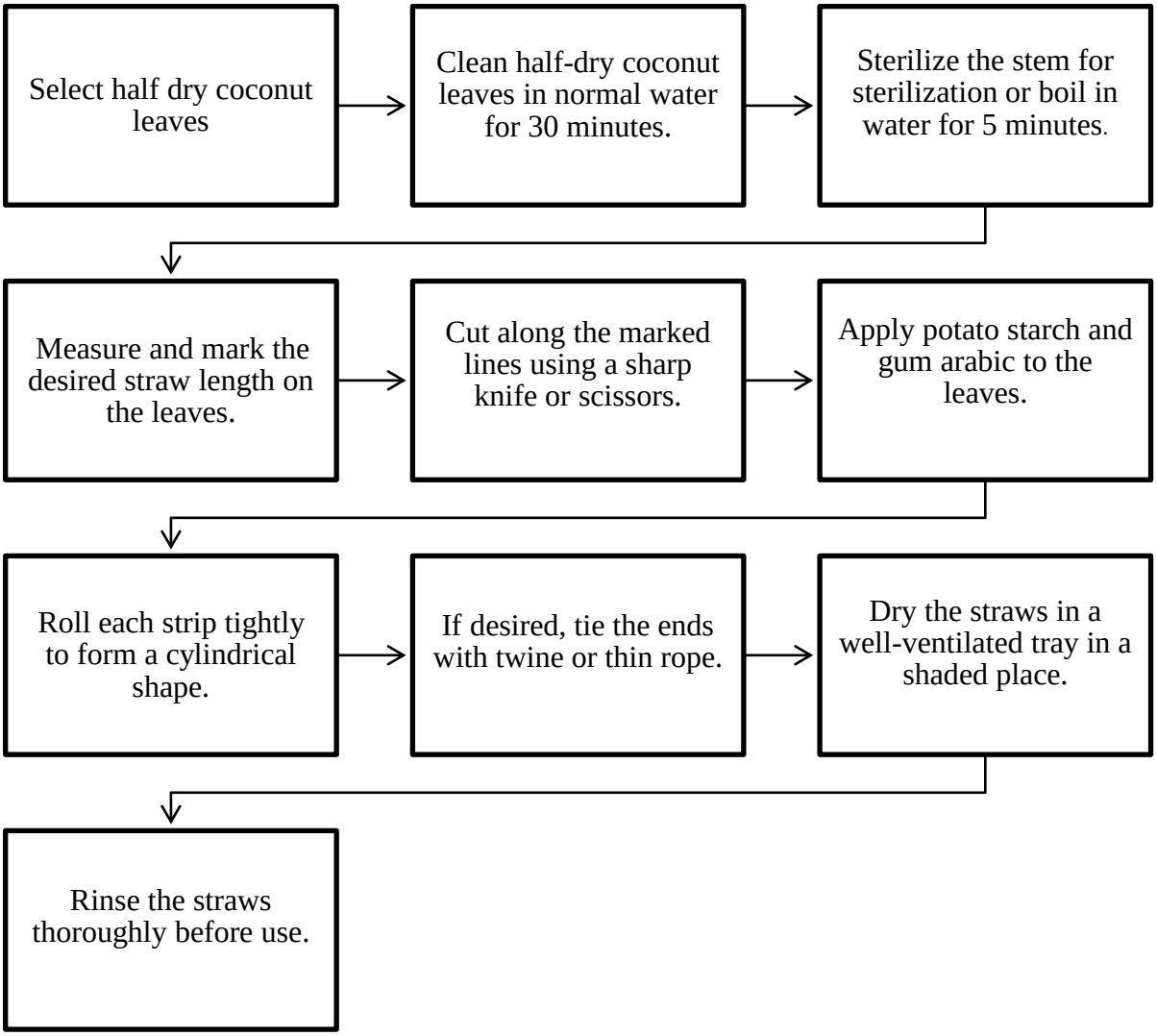


**Fig 2:** The final product – straw made from coconut leaf

**Phytochemical analysis: Total Flavonoid Content & Total Phenol Content**

**Materials:**

- Plant samples – Leaves & Straw: Fine powder
- Filter paper
- Beakers
- Petri plates
- Test tubes
- Test tube stand

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- Cuvette

**Chemicals:**

- Methanol
- Aluminium chloride
- Potassium acetate
- Folin – Ciocalteu reagent
- Sodium carbonate
- Gallic acid
- Distilled water

**Instruments:**

- Weighing balance
- Shaker
- Spectrophotometer

**Methodology of preparation of samples for Phytochemical analysis: TFC & TPC**

The dried leaf samples and straw were grinded into a fine powder and used for phytochemical analysis. About 10g of the powdered plant sample was extracted with 100 ml of methanol. The slurry was shaken for 24 hours in the shaker and then placed in a filter to get the filtrate plant sample. Methanol was evaporated at room temperature in about 4 to 5 hours.


**Fig 3:** Preparation of samples

**Estimation of Total Flavonoid Content (TFC) in a plant sample:**

500 µl of the extract of leaves and straw of the selected plant sample *Cocos nucifera* L. were mixed with 1500 µl of 95% methanol, and then 100 µl of aluminium chloride (10%) and potassium acetate (1M) were added, respectively, and the volume was raised to 10 ml with distilled water and agitated. Incubation was done for 20–30 minutes at room temperature. The absorbance was assessed at 415 nm against a blank containing all the reagents without the sample using a spectrophotometer. The measurement was done in triplicate, and the total flavonoid was quantified by the standard curve of quercetin solution.

**Estimation of Total Phenol Content (TPC) in a plant sample:**

1 ml of the extracts of the plant samples were thoroughly mixed with 10 ml of distilled water and added to 1.5 ml of Folin - Ciocalteu reagent. After 5 minutes, 4 ml of 20% sodium carbonate ($Na_2CO_3$) was added, adjusted with distilled water up to 25 ml, and agitated. Then it was incubated for 30 minutes at room temperature. The absorbance was measured at 765 nm against a blank containing all the reagents, excluding the sample, using a spectrophotometer. This procedure was repeated three times for each extract. The total phenol was quantified by the standard curve of Gallic acid solution, which was prepared using a similar procedure.

## III. RESULTS & DISCUSSION

**A description of the straws made of coconut leaves:**

The coconut leaf straws were made using mature leaves from nearby coconut trees. The leaves were carefully harvested and processed to create cylindrical straws that looked like regular drinking straws. Despite minor differences in length and diameter, the straws had a consistent appearance due to the natural variations in the coconut leaves.

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**Physical characteristics:**

- Length: The coconut leaf straws ranged in length from 20 to 25 cm, with an average length of 22 cm.
- Measurement: The straws had an average diameter of 6 mm, with a range of 5 to 7mm.
- Thickness: The coconut leaf straws had an average thickness of 0.5 mm, with modest variations in thickness along their length.

**Durability and Strength:**

The coconut leaf straws demonstrated good durability and strength in tests. The straws were flexible enough to bend without leaking, indicating they could be used with various beverages. However, the straws showed some differences in strength, with thicker ones being more resistant to bending and breaking.


**Fig 4:** Coconut leaf straw in normal water, hot water, cold drink in different time duration

**Water Absorption:**

The straws made from coconut leaves were tested for their water absorption capabilities. Even after being submerged in water for an extended period, the straws absorbed very little water and did not swell or become deformed. This indicates that the coconut leaf straws may be suitable for use with liquid beverages, as they are resistant to moisture while maintaining their structural stability.

**Biodegradability:**

Coconut leaf straws were put through composting tests to see how easily they break down. Over five weeks, the straws gradually decayed and seeped into the soil below. This shows that the straws made from coconut leaves can decompose, so they're safe to dispose of in composting facilities. Using these biodegradable straws helps protect the environment.


**Fig 5:** Degradation time of straw in soil

**Analysis of TPC & TFC tests:**

1. Strengthening: TFC and TPC act as binding agents, strengthening the structure of the straws. This helps prevent them from becoming too soft or breaking apart easily when in use, improving their durability.
2. Water Resistance: The condensation products provide a protective layer that makes the straws more resistant to moisture. This is particularly beneficial for drinking straws, as they are constantly in contact with liquids and need to maintain their integrity over time.
3. Extended Lifespan: The coconut leaf straws' lifespan is increased by reinforcing them with TFC and TPC. They survive longer because of their decreased susceptibility to deterioration from frequent usage and contact with liquids.
4. Improved Handling: The addition of TFC and TPC may also improve the handling of the coconut leaf straws. This makes them easier to hold and use without collapsing or becoming too soft.

Overall, adding TFC and TPC to coconut leaf drinking straws enhances their durability, water resistance, and usability. This makes them better eco-friendly alternatives to plastic straws for practical use.

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**Total Flavonoid Content (TFC) in a plant sample:**

In *Cocos nucifera* L. the total flavonoid content were found highest in the coconut leaves and lowest was found in the coconut leaf straw in methanol extract.

**Table 1:** Total Flavonoid of plant sample

| SOLVENT | TOTAL FLAVONOID | |
|---|---|---|
| METHANOL | LEAVES | STRAW |
| | 612.83±0.054 | 297.83±0.25 |

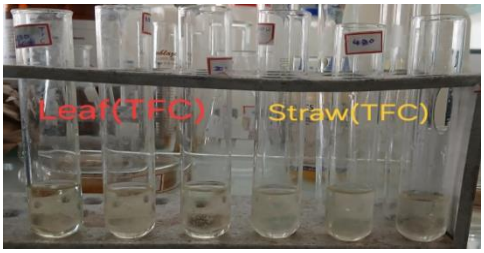


**Fig 6:** TFC final result

**Total Phenol Content (TPC) in a plant sample:**

In *Cocos nucifera* L. the total phenol content were found highest in the coconut leaves and lowest was found in the coconut leaf straw in methanol extract.

**Table 2:** Total Phenol of plant sample

| SOLVENT | TOTAL FLAVONOID | |
|---|---|---|
| METHANOL | LEAVES | STRAW |
| | 14.179±0.024 | 10.507±0.031 |

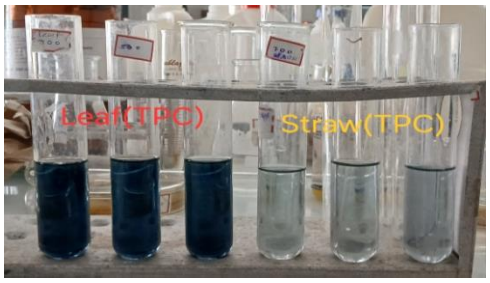


**Fig 7:** TPC final result

**Comparing with current alternatives:**

Coconut leaf straws offer an eco-friendly alternative to plastic straws. These straws are harvested from renewable coconut trees, minimizing environmental harm and making them a sustainable choice. While other options like paper, bamboo, metal, and bioplastics exist, coconut leaf straws stand out with their natural appearance and unique, fibrous texture. However, the quality may differ compared to other alternatives. For instance, paper straws can get soggy quickly, and metal straws can affect the taste of drinks. Overall, coconut leaf straws provide an environmentally friendly straw option with a distinctive user experience.

**Green manufacturing process:**

Coconut leaves make for eco-friendly straws. These straws come from the fallen leaves of coconut palm trees, a never-ending natural resource. In contrast, plastic straws contribute to pollution and take a long time to break down. Coconut leaf straws are not only environmentally friendly but also compostable. Additionally, the production process for coconut straws is eco-friendlier than that of bamboo straws. Bamboo straws require chopping, drying, and cutting the stems, making the process less sustainable.

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**Resilience and longevity:**

Naturally, you may assume that straws made of coconut leaf are not as durable as straws made of plastic. However, the durability and lifespan of these straws are rather remarkable. Leaves have the necessary structural endurance to handle liquids for extended periods of time because of the internal fibers. Unlike papaya straws, which can become floppy and lose their shape, coconut leaf straws maintain their rigidity, guaranteeing that you can still enjoy your beverages without any consequences.

**Flexible and visually pleasing:**

Coconut leaf straws are both flexible and aesthetically beautiful, which enhances the whole drinking experience. Perfect for mixed cocktails, smoothies, and refreshing beverages, these straws' natural texture and earthy colors create a lovely and ethereal environment. Their versatility allows them to suit a variety of beverage types in a variety of sizes. Coconut leaf straws can handle every type of beverage, from a thick milkshake to a delicate herbal tea.

**Steering clear of chemical hazards:**

One of the main concerns when using plastic straws is the possibility of dangerous chemicals leaking into beverages. Coconut leaf straws promise the freshness and unadulterated quality of your drink while providing a risk-free alternative. Unlike paper straws, which can be enhanced with glues or chemical coatings, coconut leaf straws do not contain these substances, guaranteeing a safe and enjoyable sipping experience.

**Encouraging neighbourhood societies:**

In areas where coconut trees are abundant, the process of making straw from their leaves usually includes adjacent communities. You may contribute to the financial advancement of these communities by choosing these environmentally beneficial alternatives. Additionally, supporting regional businesses lowers the greenhouse gas emissions associated with long-distance transportation, strengthening the eco-friendly advantages of coconut leaf straws.

**Effect on the environment:**

Presenting a Coconut Leaf-Based Eco-Friendly Straw Creating jobs for women in rural places, this straw not only lowers greenhouse gas emissions but also gives them more power. Its chemical-free, environmentally friendly manufacturing technique replaces paraffin wax with coconut wax to provide water resistance. The company's current priorities include expanding globally and reducing its environmental impact.

**Future directions and challenges:**

The coconut industry can improve sustainability by investing in automated harvesting and processing machines, partnering with local communities for responsible sourcing, and streamlining production processes. Expanding coconut leaf-based products beyond drinking straws and promoting eco-friendly alternatives can also be beneficial. Challenges include standardized manufacturing, cost competitiveness, waste reduction, economies of scale, and regulatory compliance. Promoting composting, recycling, and biodegradation can help minimize environmental impacts and ensure product quality.

## IV. CONCLUSION

Coconut leaves can be made into environmentally friendly straws. This material offers many benefits for the environment. It reduces waste, captures carbon, saves resources, and uses energy efficiently. Using coconut leaf straws means less waste in landfills and less pollution, which helps fight climate change. Making coconut leaf straws may also use less energy, leading to lower carbon emissions. This material also creates economic opportunities. It provides income for coconut farmers and communities and can save costs for companies and individuals using the straws. Using coconut leaf straw can help improve rural areas, bring communities together, and preserve important cultural practices in regions where coconut trees are significant. Further research and development can lead to innovative, sustainable materials and manufacturing methods.

Single-use plastic pollution, littering, marine pollution, and landfill issues are significant environmental concerns. Sustainable materials like corn starch and bamboo can be used as alternatives to common plastic cutlery, and reusable cutlery can help reduce waste.

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The study explores the use of compostable cutlery, examining how well it performs in different settings and its potential benefits for the environment. It looks at factors like user acceptance, environmental impact, and key performance measures. The analysis considers the composition of the biodegradable material, exploring its ecological implications and impacts on natural resources. Overall, the study provides a comprehensive understanding of compostable cutlery and its role in reducing plastic waste.

The use of biodegradable cutlery by people brings up various thoughts and ideas. Environmental factors are weighed against the long-term economic benefits and production costs of biodegradable cutlery, pointing out any trade-offs or issues with cost-effectiveness. Laws could either help or hinder the widespread adoption of biodegradable cutlery. Projects examining biodegradable tableware look at its potential to address environmental issues and suggest further research and development. The review considers universal access to eco-friendly, biodegradable cutlery, analyzing various relevant factors.

Microbes, like Bacillus, Actinobacteria, and Pseudomonas, play a role in breaking down biodegradable materials in the environment. Biodegradable means these materials can be effectively broken down, and different microbes may be involved in the decaying process.

Using eco-friendly utensils rather than regular plastic cutlery is a better choice, as plastic harms the environment and all living things.

Governments can support the use of sustainable materials like coconut leaf straw through policies. Raising awareness among consumers about the benefits of coconut leaf straw could increase demand for eco-friendly products. Using coconut leaf straw as a sustainable material can have beneficial effects on the environment, economy, society, and culture. It can also promote innovation and resource preservation. However, it's important to carefully consider factors like scalability, durability, and local circumstances when implementing such initiatives to ensure their effectiveness.

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