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REVIEW ARTICLE

Ecofriendly plant-based alternatives to replace disposable plastic straws

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Abstract

Waste management of plastic has been one of the main ecological problems throughout the world. As they are nondegradable, they remain in landfills and sea for hundreds of years. Also microplastics have become a major health hazard for humans as well as animals. Disposable plastic straws have become very popular around the world as they are convenient to use and cheaper. Waste management of single use plastic in general and disposable plastic straws in particular has become a serious problem and public has been demanding banning of such plastic products. The success of such a step depends on the availability of ecofriendly alternatives. Now many alternatives, largely from plant sources, are available. They include reusable as well as disposable straws. Reusable straws are made from bamboos and also from steel, glass and silicon. Disposable straws are made from plant products such as paper, grass, sugar cane bagasse, coconut leaves, and ground coffee. Even edible straws prepared from pasta, corn, rice flour and tapioca, and seaweeds are now available. Reusable bamboo straws and all disposable straws are compostable and biodegradable. Governments worldwide have started banning single use plastics. Hopefully, these measures combined with public receptivity for eco-friendly items would soon lead to complete replacement of plastic straws with eco-friendly straws.

Keywords: Ecofriendly straws, Edible straws, Limitations of plastic straws, Straws from plant products, Waste management of plastics.

Introduction

Post-industrialization advances in all walks of life have no doubt made human life more comfortable. At the same time many of them have created a number of serious ecological problems. Waste management of plastics, especially of single use plastics, has been one such problem throughout the world. Widespread use of plastics started in 1950s. Soon it was considered as a wonder creation and since 1980s it has become difficult to imagine a world without plastics. Nobody thought about environmental problems they would create. Plastic is non-degradable and remain in landfills and sea for hundreds of years. In 2015 itself, as much as 79% of about 6300 million metric tons of plastic waste generated has accumulated in landfills and natural environment (Geyer *et al*. 2017). Plastic waste has now become ubiquitous. Everyday approximately 8 million pieces of discarded plastic find their way into our oceans. Plastics consistently make up 60-90% of all marine debris. In 2010 alone, an estimated 4-12 million metric tons of plastic waste has been estimated to have entered the sea (Jambeck *et al.* 2015). Nearly 50 percent of all plastic produced (to manufacture daily use items such as plastic bags, drinking straws, packaging material and disposable cutlery) is for single use. Only 9% of single use plastic is being recycled. Microplastics (small breakdown plastic particles and fibres less than 5 mm in length), produced largely from single use plastic waste, enter the food chain of humans and animals through the air, drinking water, food and dust creating serious health hazards.

Disposable plastic straws are one of the single use plastic products being used extensively though out the world. Drinking straws have been in use since long, mush before plastic was invented. Marvin Stone devised paper straws as early as1888 for the first time and subsequently refined them by using paraffin-coated manila paper to prevent them from becoming soggy. He patented it in 1890 and his factory started mass producing them. Joseph B. Friedman was the first to devise bending (flexible) paper straw. His company

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(Flex-Straw) started producing them (https://invention.si.edu› straight-truth-about-flexible-…).

Since 1960s plastic became more practical and cheaper material for production of straws and soon they started replacing paper straws. As plastic straws were better, more convenient to use and cheaper than paper straws available at that time, a large number of companies started producing disposable plastic straws and they became very popular throughout the world. By late 1960s plastic straws replaced paper straws almost completely. In 1980s bendable plastic straws became available which made them more useful particularly for sick and disabled people. According to an estimate, 500 million straws are used every day in the US alone. They are not used for recycling as they are difficult to collect and recycling companies do not take them as they are contaminated with food particles.

The world is now struggling to escape from plastic pollution in general and plastic straws in particular. Elimination or significant reduction in the use of plastic straws depends on the availability of ecofriendly and efficient alternatives. Many companies have come up in recent years to manufacture eco-friendly straws to mitigate environmental problems created by plastic disposable straws. This article briefly describes available eco-friendly alternative drinking straws largely made from plant sources.

Alternatives to Plastic Straws

Non-plastic drinking straws include reusable as well as disposable straws. Reusable straws include bamboo straws and also silicon, steel and glass straws. They can be used with cold as well as hot drinks. Each package of reusable straws generally comes with a suitable brush to clean them after each use. Some of them can also be washed in dish washer. Silicon, steel and glass straws can be recycled. Disposable straws are made from a range of plant sources which are readily compostable and biodegradable. Some of them are even edible. All plant-based straws are non-toxic and safe.

Reusable Non-plastic Straws

Bamboo straws

Fast growing species such as *Fargesia spathacea, Phyllostachys pubescens* and *Schizostachyum andamanicum,* characterized by hollow stem, are used for making bamboo straws. Thin narrow stalks with long internodes are harvested and dried under the sun. They are then cut to the size, polished to smoothen the cut ends and the surface, thoroughly washed and used to prepare straws (Figure 1 A, B). As these straws are durable, they can be washed and reused for years with proper care. When they get old showing cracks at the cut ends and no more usable, they can be put in the compost bin. Vietnam is one of the major countries that produce bamboo straws. They are not dish-washable and need to be cleaned with a brush. Even reusable cutlery items such as spoons, forks and knives are also prepared from bamboos.

Silicon straws

They are prepared from food grade silicon and are safe, non-toxic, stain-resistant, long-lasting and are available in different sizes in bright colours. As they are see-through types, one can easily spot anything stuck inside the straw. As they are the only flexible and collapsible reusable straws, they are presently appear to be more popular.

Stainless steel straws

The steel used for straws is of the best quality and generally nickel-free to prevent corrosion. They are dishwasher safe. They last almost forever and can be recycled. They share most of the qualities of silicon straws except that they are not flexible and collapsible, and are not see through. However bent steel straws are available so that they can be used by bed-ridden patients. The straw may get hot when used for hot drinks, making them inconvenient particularly for kids.

Glass straws

Glass straws are made from long-lasting, heat-resistant 'borosilicate' glass. They are very convenient, safe and are available in a wide range of colours. Bent glass straws are also available. All glass straws are easy to recycle. They are not flexible and tend to break when mishandled; not safe for kids.

Disposable Non-plastic Straws

Disposable straws include paper straws, grass straws, sugar cane straws and straws from dried coconut leaves.

Paper straws

Conventional paper straws made exclusively of paper become too soggy when they come in contact with liquids. They have to be coated with some suitable biodegradable material to prevent their sogginess. Most of the paper straws available in the market are coated with Polylactic acid (PLA) made from fermented plant starch from corn, maize or cassava. They contain fewer toxic substances compared to traditional polypropylene plastics.

Recently many biodegradable plastics have been developed to coat paper straws (Kwak *et al.* 2022). One of them is polybutylene succinate containing a small amount of cellulose nanocrystals. When coated with this material, paper straws do not become soggy on contact with liquids.

Figure 1: Reusable straws: Bamboo stalks used for straws (A) and a sample of bamboo straws of different sizes (B). (Credit: Shutterstock)

Hello Straw, an European Company, has specialized in manufacturing 100% biodegradable eco-friendly paper straws and paper cutlery items of various types and sizes. It has offices in several European countries and production facilities in Poland, China and Vietnam. Recently, another plastic formulation that is suitable for making straws, polyhydroxyalkanoate (PHA), produced by bacteria under controlled conditions is also available. As it is a natural material, it is biodegradable. The straws made from this material resist hot liquids without altering the flavour of the drink. PHA is expensive at present. Oceanic Resins S.L. is already manufacturing these straws and they are likely to be commercially available soon (https://phys.org/news/2019-11-straws-polyhydroxyalkanoate-pha-plastic.html).

A few negative points of paper straws are that the paper as the raw material has considerable carbon footprint since it leads to deforestation. Also, paper production itself is not ecofriendly as it contributes to air and water pollution. Most of the paper straws are not recyclable as they are considered food-contaminated although they are biodegradable.

Grass Straws

A company from Vietnam has been very successful in producing grass straws made from sedge grass (*Lepironia articulata*), which grows profusely on Mekong river delta. Sedge straws are non-soggy and comparable to plastic straws in style and elegance (Figure 2A-C). Although they are essentially disposable, they can be reused for a few days with care. The availability of grass is made sustainable by leaving 10% of the field unharvested and used for replanting; it also protects the ecosystem (https://www.strawlific.com/).

Sugar cane straws

Ecofriendly sugar cane straws are produced by using leftover sugarcane bagasse after extraction of sugar (https://www.ecogreenstraws.com › sugarcane-straws). Sugarcane straws can be used for hot and cold drinks, and do not affect the composition of the liquid they come in contact with. As agricultural waste from sugar production, these straws are biodegradable. There are a number of companies located in China, Taiwan, and a few other countries which make sugar cane straws. These are considered as one of the best alternatives to plastic straws.

Straws from coconut leaves

These straws are made from dry coconut leaflets and are 100% biodegradable. The company, Sunbird Straws, is located in India. The hard stalk (petiole) of the coconut leaves are generally used as firewood and the midrib of the leaflets are used for making brooms. The lamina of the leaflets (after taking out the midrib), which is generally discarded, is used for making straws (Figure 3 A). About 200 straws can be made from one coconut leaf. As there is continuous supply of coconut leaves from coconut plantations, the raw material is sustainable. These straws have antifungal and hydrophobic outer and inner walls and do not become soggy on contact with liquids. The company claims to have received orders for about 20 million straws from over 10 countries.

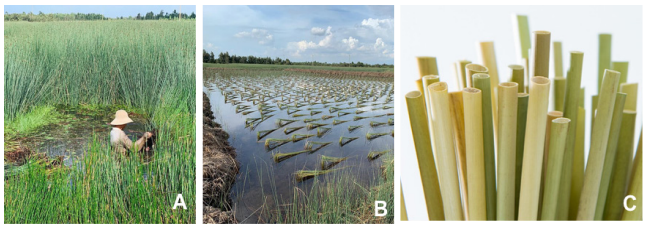

Figure 2: Fields of sedge grass used for grass straws (A, B) and sample of grass straws (C) (Credit: Strawlific Com.)

Figure 3: A. Disposable straws made from dry coconut leaves (Credit: Sunbird Straws). B. Edible straws made from pasta (Credit: Stroodles Eco-table ware)

Coffee Straws

These straws are made from recycled, 100% ground coffee (the sediment that remains after ground coffee beans have been extracted with hot water). Coffee straws are odourless, tasteless, non-toxic and contain no chemicals. They can be used equally well in either hot or cold drinks and they do not become soggy. They are compostable and biodegradable.

Edible Straws

In recent years edible straws are also being made by several companies using a variety of plant-based products. They can be eaten or cooked after drinking the liquid or disposed as they are readily biodegradable. Sorbos company produces corn straws and they are allergen and gluten free. They are available in five different varieties, including unflavoured lime, lemon, chocolate and strawberry. They will not change the colour of the drink. The company claims that they are the first to produce 100% sustainable straws on the market. A Vietnamese company manufactures straws made from fresh rice flour and tapioca without using any chemical preservatives. Pasta straws are made from organic blend of water and durum wheat flour (Figure 3 B). They are edible, free from any flavour and biodegradable when discarded.

Loliware company from Hawaii makes straws from seaweeds. Seaweeds refer to a large number of macro-marine algae belonging to Rhodophyta (red algae), Phaeophyta

(brown algae) and Chlorophyta (green algae). Dry seaweeds are milled down into pellets and are combined with minerals, colour and water and transformed into straws using the same machinery used for making plastic straws. As seaweeds grow abundantly in the ocean, they are sustainable.

Most of the edible straws have a safe life of about 2 years when stored in a dry place. As they are easily biodegradable, those which are not used for eating purpose can be thrown to decompose. The dye used for edible straws is not from chemicals but from vegetables and fruits.

Conclusions

Environmental protection is now considered a non-negotiable task. Environmental degradation with plastic straws is no more needed as a range of environmental friendly non-plastic and biodegradable straws are available. One of the limitations of eco-friendly straws has been that they are more expensive than plastic straws; this is particularly a factor in developing countries. With improvement in technologies and sale of products the cost is expected to come down in the coming years. Also, people are becoming environmentally conscious and are willing to pay extra cost. Reusable straws can be used for years with care. Edible straws are a novelty. The businesses are increasingly feeling public pressure to use alternative straws. Banning of plastic straws by Governments is an important step toward ultimate goal of preventing the circulation of single-use plastic. The United Kingdom and some States in the United States have banned single use plastics including plastic straws; it is gradually extending to other territories. Beverage manufacturers in India use around six billion straws annually (https://m.economictimes.com › Small Biz › SME Sector). Although India has banned many single use plastic items including plastic straws from July 2022, its implementation has not been very effective; banned straws are still available in some metropolitan cities. However, the demand for ecofriendly straws is growing in India also and many startup companies are coming up. Hopefully a day will come in the near future, where disposable plastic straws are no more available.

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