

An invention of reusable eco-friendly drinking straw: An overview

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Abstract

The present paper describes for the first time the invention of a reusable eco-friendly drinking straw and its manufacturing process. It is made up of purely natural and biodegradable material (an endemic bamboo species, *Schizostachyum andamanicum*). I discovered the potential of the culms of this bamboo as a drinking straw during a morpho-anatomical study and invented a manufacturing process for their use and reusability as an eco-friendly drinking straw which has good resistance against microbial contamination. This invention is economically feasible as well as ecologically significant as it is aimed at reducing the use of single-use plastic. The present study also described the morpho-anatomical diversity of the culm of S. andamanicum and its conservation status in great detail the first time.

Key words: Anatomy; Bambusoideae; Culms; Environment; Invention; Straw.

Introduction

The straw is an integral tool in the food and beverage industry. It originated with Mesopotamians. They use natural straws like ryegrass. Early applications, especially for beer, showed a novel way to avoid tea leaves in liquids. The earliest drinking straw was found in a Sumerian tomb dated 3000 B.C. it was a tube made from gold and precious blue stone lapis lazuli. In the 1800s the rye grass straw came into fashion because it was cheap and soft. The first known primitive natural straw made from the stem of grass strains with large hollow stems. The name straw comes from the fact they were literally made of straw (Kramer, 1963; Martha, 1995; Foster, 1996; Nemet Nejat, 1998). Modern drinking straws are made from various metals, glasses, plastic and other synthetic fibers. These are very expensive and have an environmental hazard. Keeping in view of this fact, the present invention is a novel way to replace the environmentally hazardous straws. Therefore, it is considered highly imperative to study, the genetic resource with a view to use this species in future breeding programme, to encourage the local people for plantation of this species to enhance the productivity and its conservation for use of eco-friendly, biodegradable product in daily life.

During the morpho-anatomical investigation of culms of *Schizostachyum andamanicum* M. Kumar and Remesh

(Poaceae), an endemic to Andaman and Nicobar Islands (ANI), I had led into the idea of utilizing the potential use of this species as a drinking straw in 2011. Further, a study was conducted to support this hypothesis regarding the making of straw from bamboo which was simulated by its manufacturing technique and process to acquire the specialized quality as a reusable tool. Functional efficiency of any organism is directly associated with morpho-anatomical structure. A drinking straw is a short tube intended for transferring drink from its container to the mouth of the drinker by use of suction pressure. Based on findings of morpho-anatomical study it was discovered that the potentiality of culms of this bamboo species as a drinking straw and I got success as an invention of reusable eco-friendly drinking straw.

Culms of *S. andamanicum* used as material for present invention which is a semi-scandent sympodial bamboo, restricted in distribution in the Islands. Except taxonomy no reports are available on the anatomy and potential use of this endemic bamboo (Dransfield, 1983, 2000; Kumar and Ramesh, 2003). Although, ANI are one of the hotspots of biodiversity with 572 Islands (N 6°45' to 13°41' and E 92°12' to 93°37' and recognized as a rich and unique phytogeographical region in India with higher number of endemism (Singh *et al.*, 2014, 2021a,b; Singh and Misra, 2020; Singh and Ranjan, 2021).

The morpho-anatomical characters have considerable taxonomic importance and used for identification at different hierarchical levels (De Bary, 1884; Solereder, 1908; Jeffrey, 1917; Arber, 1925; Eames and Mac Daniels, 1947; Metchalfe and Chalk, 1950; Metcalfe, 1960; Esau, 1965; Pant, 1965; Grosser and Liese, 1971; Foster and Gifford, 1973; Fahn, 1982; Liese, 1987; Wen and Chou, 1987; Mauseth, 1988; Misra and Singh 2000; Singh, 2002; Singh and Misra, 2012, 2015, 2024a, b; Yadav *et al.*, 2023; Singh *et al.*, 2025). The morpho-anatomical characters also help to find out the potentiality of the any organism which has not given any attention to *Schizostachyum andamanicum* prior to the present study. Hence, the morpho-anatomical study of *S. andamanicum* presented here in great detail for the first time.

Material and Methods

The demonstration and Experimental observations of present invention were conducted at Dhanikhari Experimental Garden-cum-Arboretum (DEGCA) and Laboratory of Botanical Survey of India (BSI), Andaman and Nicobar Regional Centre (ANRC) respectively. During the demonstration, people from different walks of life including eminent persons were involved. Most of them expressed their appreciation of the present invention.

Manufacturing process of this eco friendly drinking straw is very simple and has demonstrated property of natural disinfectant and thus is reusable many times. This has been proved by demonstration, micro-morphological observation along with morpho-anatomical studies (Fig.1-3). Potential of morpho-anatomical feature of culm of this endemic bamboo species as a drinking straw has been evaluated through morpho-anatomical study of Culm and demonstration.

The fresh materials (stem cuttings) collected from live clump grown at DEGCA and local forest areas for morpho-anatomical study and subsequently materials were fixed F.A.A. for microscopic study. To verify the identity of species, critical analysis of morphological characters was carried out by comparing our collections with the herbarium specimens housed in PBL and other online herbaria and consulted the relevant literatures



(Munro, 1868; Gamble, 1896; Brandis, 1906; Parkinson, 1921; Dransfield, 1983, 2000; Wong, 1995, Obmberger, 1999; Kumar and Ramesh, 2003). The external morphology of stem was studied by technique followed by Misra and Singh (2000). The method of preparation of microscopic anatomical slides adopted after Johanson (1940). Photomicrographs of sections of stem were taken from Leitz microscope

Result

Manufacturing Process : Fig. 1-2.

Culms were made usable as an eco-friendly drinking straw after investigating morpho-anatomical characters which has lead the idea of utilizing its potential use as a drinking straw by the inventor to suppress the modern synthetic drinking straw made from plastic and other synthetic fibers. Inventor finding out a clear and simple manufacturing process to reform it in a usable form through various steps *viz*. material organization, material processing, production and application/use. After usage, re-use after the appropriate decontamination, cleaning, disinfection and sterilization followed by drying, storage and ready for re-use (Fig. 2a-k). The manufacturing and re-usable technology has been granted a patent in the year 2023.

Experimental data that supports the various experiments includes testing of microbial or fungal contamination. Experimental procedures followed for microbial contamination assessment are provided in the Patent Manufacturing Technology (PMT). During microbial examination process, no microbial growth/ contamination was observed on all straws subjected for examination after 48 hours of incubation for microbial analysis (Fig. 2). There are several advantages of this invention, notable ones are (1) eco-friendly and biodegradable material; (2) resource material easily cultivable (3) material with good resistance property against microbial contamination even with repeated use; (4) non-staining; (5) simple manufacturing process (6) low-cost technology; (7) easy to use and re-use; (8) unaffected by water hardness; (9) effective deodorizer and disinfectant; (10) does not leave toxic residues.

Keeping in view of economy and in terms of ecological balance to reduce environmental degradation, it is an invention of economically important as well as ecologically significant product. In future it will emerge as preferred choice not only in the ANI but also at global level because the aforesaid bamboo species can easily be cultivated to meet the requirement of global demand for eco friendly natural products.

Demonstration

During demonstration fresh thin culm (stem) cuttings were prepared as a normal size of modern straws especially inter nodal parts *viz*.20-25 cm in length and latter on it is employed by being held with one end in the mouth and another end in the drink (dab pani/tender coconut water: liquid of coconut: *Cocos nucifera* L. (Aracaceae), subsequently start drinking. During the course of drinking muscular action reduces air pressure in the mouth, when upon atmospheric pressure forces the drinks up the straw (Fig.2 l) this was the first observation on potential as a drinking straw. Thereafter, it was also employed in the hot and cool drinks for testing of toxic residues and stain. Observations revealed that it will be useful to take all kinds of drinks.

Implication

After registration of this invention with the patent Office of Govt. of India, BSI has distributed 5000 samples of the straws at India Gate, New Delhi when India was the global host country for World Environment Day in 2018, with the theme "Beat Plastic Pollution" on 5th June in the gracious presence of honourable Ministers and Officials of Ministry of Environment, Forest & Climate Change, Govt. of India. The application of eco-friendly drinking straw is much impressed and highly appreciated by the people from different walks of life including eminent persons. Since 2018 BSI has been distributing this reusable eco friendly straws on the different occasions to create awareness about avoid the single use plastics.

Morpho-Anatomical Observations: Fig. 3.

External Morphology of Stem / Culm

S. andamanicum is semi scandent sympodial bamboo with highly straggling culms arching over neighboring

plants and forming large bushes. It is characterized by thin, large, hollow, erect culm with longer internodes sometimes multiple branches arises from nodes. Nodes are not hollow, somewhat swollen with a smooth spongy nodal rings and hairy culm sheath. Internodes hollow with wide central lumen, 16-25 x 0.3-0.6 cm, pale green with purplish tinge in colour when young and become yellowish green to golden yellow at maturity, clothed with minute silky hairs. Branch complements typically a cluster of slender sub equal branches, culm sheath rigid, 13-12 x 4-6 cm, at apex 4-5 cm wide, gravish green with purplish orange tinge, clothed with brown hairs; auricle small, elongated, dark brown, up to 2 mm long with many long silky white bristles; culm sheath blade linear lanceolate, 5-7 x 0.8 cm, purplish brown bearing few bristles near the round of basal part, inner surface sparsely hairy, hair silky white, outer glabrous, ligules up to 2 mm long.

Anatomy of Stem/ Culm

In cross section, culm shows chiefly three parts viz., dermal, ground and vascular. Dermal parts consist of two impermeable epidermal layers at outer and inner side of culm. The outer one is covered by a cutinized layer with a waxy coating. The culm is covered by leaf sheath at nodal regions and its epidermis shows the presence of long tubular as well as papillate hairs. Below the epidermis it is a ground tissue with scattered vascular bundles. The ground tissues are parenchymatous, oval or spherical in shape and shows uniform pattern of parenchymatous cells with intercellular spaces. Chloroplasts are also present in outer ground cells. The ground region composed of 28 to 36 cells in thickness. Outer part consists of much smaller vascular bundles where as inner part consists of fewer larger vascular bundles. These vascular bundles consist of one or two protoxylem vessel, two metaxylem vessels and the phloem with thin walled unlignified sieve tubes associated with companion cells. The vascular strands are surrounded by well-developed sclerenchymatous cells. The central part of internodal region occupied by wide schizogenous cavity whereas central part of nodal region is solid and composed of sclerenchymatous cells.



Fig.1. Manufacturing of investigation by inventor (Lal Ji Singh): a. Tools used in processing of straw; b. Collecting bamboo material for eco-friendly straw preparation (raw material collection); c-h. Processing the raw bamboo material; i. Processed bamboo natural re-usable drinking straws ready for use.





Fig.2. Invention to Demonstration of eco-friendly re-usable straw: a–k. Experimental observations at laboratory by inventor (Lal Ji Singh); l. Demonstration.





Fig.3. Morpho-anatomical details of *Schizostachyum andamanicum* M. Kumar & Remesh: a. Habit; b. Clum axis with leaf; c. Clum with sheath showing external morphology of nodal region; d. Internal view with wide lumen in L.S.; e. inter nodal region in T.S.; f. Nodal region in T.S. (young); g. Nodal region in T.S. (mature); h. Clum sheath hair in T.S.

Conservation Status

During field surveys conducted between 2011-2025 it was observed that this species is restricted in distribution and found only naturally growing in few forested areas of Andaman group of Islands. Field and herbarium data revealed that the natural population of this species has declined due to human activity, climate change and habitat loss, resulting in the reduction of its Area of Occupancy (AOO) and Extent of Occurrence (EOO). Therefore, there is a need for serious attention for their *ex-situ* as well as *in-situ* conservation. As a part of *ex-situ* conservation this species has been conserved at DECGA, Andaman and Nicobar Regional Centre of Botanical Survey of India.

Discussion

The morpho-anatomical characters have considerable taxonomic importance and used for identification of bamboos (Grosser and Liese, 1971; Liese, 1987; Wen and Chou, 1987). However, anatomical studies on Indian bamboos are limited mainly to culms and leaves (Gosh and Negi, 1960; Pant and Mehra, 1961; Pattanath and Rao, 1969). However, anatomical details of S. andamanicum have not been studied earlier because of its endemism. The present study describes the morpho anatomical diversity of culm of S. and amanicum along with their potential as ecofriendly drinking straw and its manufacturing technology in great detail for the first time. Anatomical structure of culm of this bamboo species enable its potential as a drinking straw as functional efficiency of any organism is directly associated with structural architecture of the organism recorded by various workers.

A drinking straw is a short tube intended for transferring drink from its container to the mouth of the drinker by use of suction pressure. The inter nodal part is long, tube-like, hollow, and have a large bore. So its morpho-anatomical structure is identical to a modern drinking straw. It is a novel way to replace modern synthetic and hazardous straw. Mostly modern disposable straws are not recycled even though they are made from recyclable materials and end up in landfills or the ocean. It only acts as an environmental hazard. However, culm cuttings of *S. andamanicum* used as natural drinking straws are biodegradable, hygienic, eco-friendly, and also can be reused many times.



This bamboo species started gaining importance with the discovery of its potential passage of time in the campaign to avoid single use plastic and in terms of ecological balance preventing environmental degradation. Therefore, it considered highly imperative to study, the genetic resource with a view to use this species in future breeding programme, to encourage the local people to plantation of this species to enhance the productivity and its conservation for use of ecofriendly, biodegradable product in daily life. Although, the wide variety of traditional uses of bamboo with myths and legends is well known since time immemorial and plays an essential role in the daily life of the local communities. It is one of the natural resources in the world because of its wide distribution, availability, rapid growth, easy handling, and desirable properties. It can be harvested on a regular basis without causing significant damage to its surrounding ecosystem. India, including that of the several Asian cultures believes humanity emerged from a bamboo stem. In India bamboo is also considered as symbol of friendship. In ANI, a bamboo species S. andamanicum has the potential of drinking straw, which led to an invention of a reusable eco-friendly drinking straw. This type of invention is timely the campaign against plastic pollution and need of world in terms of ecological balance preventing environmental degradation.

Conclusions

In view of socio-economy as well as ecological feasibility, the present invention is very important discovery which may pave the way for replacing single use of plastics. Therefore, the present invention is not only eco-friendly but also reusable and has great potential for export and farmers can take up for their economic wellbeing (to promote bamboo cultivation). It is a notable invention as a novel way to replace plastic drinking straws. This type of invention is timely the campaign against plastic pollution and need of world in terms of ecological balance preventing environmental degradation. If the per capita consumption of plastic has been drop down, it can be done by promoting eco-friendly (natural) products like this and other inventions based on natural products like bamboo, jute etc.

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