

## Mini Review

# Bamboo Shoot Processing in India

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## INTRODUCTION

Bamboo is a woody perennial grass belonging to the Poaceae family, which is found in tropical and sub-tropical regions of the world. More than 1250 species are known worldwide that belong to 75 genera of bamboos.<sup>1</sup> Of these, 125 species are found in India – of which only 30 are of commercial value. Bamboos play an important role in the daily life of rural people, especially in tribal regions. It is used as a wood substitute, for making industrial products; e.g., charcoal production, and for various structural applications due to its strength.

India has 677,010 sqm of forest area, of which around 16.8% is under bamboo cultivation – while only around half of this area is under bamboo cultivation in China.<sup>2</sup> In India, out of this total bamboo cultivating area, around 28% is located in the North Eastern region. This area provides nearly 66% of bamboo resources in the country, where the climate is conducive to bamboo growth.<sup>3</sup> Almost all the states in this region have bamboo growing in the forest – as high rainfall, high humidity, and optimum temperatures favor bamboo growth.

It is estimated that the global bamboo market is at \$12000 million, of which India has a mere share of 4.5% despite having 31.1% of the total bamboo growing area in the world. China leads the market by having a market share of up to 50%.<sup>2</sup> In India, the market potential was estimated to be 20,000 crores INR (equivalent to 3 billion US dollars) in 2015.<sup>4</sup>

The edible part of bamboo, which is the freshly sprouting shoot from the ground, is relished by the local people. We at the North East Centre for Technology Application and Research

(NECTAR) worked on developing the bamboo shoot sector in the country using different approaches – developing the shoot processing technology as discussed in this article, demonstrating this technology to user groups including providing assistance to set up processing facilities, supporting bamboo shoot plantation, developing package of practices for bamboo shoot cultivation,<sup>5</sup> collaborating with organizations to carry out more research on shoot processing and studying their properties, and harvesting and increasing visibility of this commercially-important food. This mini-review is focused on bamboo shoot processing and ways to exploit the yet-to-be commercialized potential of bamboo shoot in India.

## BAMBOO SHOOTS

Out of 125 species prevalent in India, the commonly edible bamboo species are *Bambusa pallida*, *Bambusa tulda*, *Bambusa polymorpha*, *Bambusa balcooa*, *Dendrocalamus hamiltonii*, *Dendrocalamus giganteus* and *Melocanna bambusoides*.<sup>1</sup> The economic value of bamboo shoots is governed by their edible content. The sheath needs to be removed before consumption and the edible portion is 14-45% (data obtained by the authors while at NECTAR), depending on the species and the size of bamboo shoots. The bamboo shoot emerges from ground having the final diameter of the culm. If allowed to grow too much, the bamboo shoot develops into culms and it hardens in form, which can no longer be eaten. Thus, there is a short window of time (approximately a couple of weeks) during which the newly-growing shoot should be harvested, typically before it is a foot long.<sup>5</sup> Also, the shelf life of bamboo shoots is very limited due to its high moisture content (around 90%).<sup>6</sup> Most of the bamboo shoots grow in deep forest areas that are not easily accessed, which makes it harder to harvest and bring out for sales

or processing.

Bamboo shoots are an intricate part of the cuisine of people living in North East India. In Manipur bamboo shoots are consumed as *usboi* which is produced by taking the sheath off, and chopping the inner soft portion of the shoot into thin slices and treating them in water for 3-4 hours. It is primarily used in the preparation of different ethnic dishes and can also be preserved for off-season by drying. The properly-processed shoots are used to make a variety of traditional local chutney called *iromba* and also are cooked as a vegetable with meat. In Arunachal Pradesh, young bamboo shoots are boiled and cut into pieces and used as a vegetable for preparation of traditional dish called *kupe*. Shoots obtained from *Bambusa balcooa*, *Bambusa nutans*, and *Dendrocalamus strictus* are bitter and need to be boiled before consumption.<sup>7</sup>

Plantations dedicated to growing bamboo shoots have started to develop recently. As an example, the *Dendrocalamus asper* species has been introduced in some regions. We at North East Centre for Technology Application and Research (NECTAR) visited one such plantation at Garh Mukteshwar (Hapur, Uttar Pradesh, India). Harvesting from such plantations can begin for bamboo shoots in its third year onwards. Some bamboo shoots must be left to grow into culms so that the plant continues to grow and produce new shoots in the next season.

In recent years (December 2016-December 2017), around 61 million Kg of canned bamboo shoots was imported into the USA from different countries: China, Thailand, Taiwan, Japan, and India – with China being the biggest player. Bamboo shoot is also a part of cuisines in many Asian countries and the demand is rapidly growing. India has exported bamboo shoots worth only \$37,885 to various countries.<sup>8</sup> China, despite having a lower area under bamboo cultivation compared to India, manages to process and export larger quantities of bamboo shoots. This is due to the dedicated plantation for shoots, their cultivation practices and presence of processing facilities near shoot-growing areas. Thus, there is a huge unexploited potential in India which can be tapped by using a certain package of practices.

## FUNCTIONAL PROPERTIES OF BAMBOO SHOOTS

Bamboo shoot is not only known for providing an exotic taste appeal, but has also been explored for their functional and health promoting attributes. It has been screened for antioxidant and anti-inflammatory effects, antimicrobial and anti-fungal effects, protection of neurons from oxidative stress, anti-apoptotic effects due to pyrolysates, as a supplement for ischemic injury treatment and for its fatigue and cholesterol reducing properties.<sup>6</sup> Recently, its dietary fibre has also been studied for its functional properties.<sup>9</sup>

## BAMBOO SHOOT PROCESSING

There are various forms in which bamboo shoots are made available in the market: canning or retorting are common methods of processing the shoots. Canned bamboo shoots stay stable for a few years and are commercially sterile. The vacuum processing the bamboo shoots in nylon-based packages is another way of

processing. This method preserves the bamboo shoots for a few months, during which they can either be consumed fresh or further canned. Fermentation and drying of the bamboo shoots are some other ways in which they can be preserved and are relished in many parts of the country; however, they change the taste and texture of the shoots and hence these products have limited applications. In contrast, fermented products are however desired and enjoyed by local people. *Mesu*, *soibum*, *ekung* and *heccha* are examples of the fermented foods<sup>10</sup> relished in different North Eastern states of India.

We at NECTAR have developed a unique method of processing bamboo shoots specific to the North East region of India and other bamboo trees growing in the remote areas of the country. This method can be considered as the minimal processing of bamboo shoots, as it preserves the original taste and texture of the shoots. Minimal processing has been defined broadly as the 'least possible treatment to achieve a purpose'. A more specific definition describes a minimal process as those which minimally influence the quality characteristics of a food while giving the food sufficient shelf life during storage and distribution. An even more precise definition which situates minimal processing methods within the context of more conventional technologies that not only preserve the food but also retain, to a greater extent, their nutritional quality and sensory characteristics by reducing the reliance on heat.<sup>11</sup>

Bamboo shoots are prone to spoilage if not preserved soon after harvesting. A high humidity and storage in the open in an environment which has a temperature of 20-30 °C are factors for their quick deterioration. Microbial action, transpiration and respiration are some of the reasons leading up to spoilage in fresh bamboo shoots. In this method developed by NECTAR, bamboo shoots can be preserved for up to 9 days (if preserved in water) or 23 days (if preserved in brine).<sup>5</sup> Since the process is very simple, it does not require considerable equipment, land or investment, and can be set up very close to the site of the shoot growing areas. Due to its simple nature, it can tap the hitherto the unexploited bamboo shoot sector.

## METHODOLOGY USED

The shoots are harvested at an opportune time – this could be between 7-14 days after their emergence, depending on the species. The shoots are washed and peeled and are soaked in water overnight. This ensures a considerable reduction of hydrocyanic acid, a cyanogen which is produced in the shoots upon harvesting. However, for complete removal of cyanogens, heat processing like boiling is crucial. This step can be carried out during subsequent processing of shoots that are packaged using this method.<sup>12</sup> Afterwards, they are cut into small or desired shapes and placed inside nylon-based packages. It is desirable to use thicker nylon packages, at least 90 microns in thickness. The package is then filled with clean potable or preferably, soft water and is heat-sealed. Instead of water, brine can also be used.<sup>5</sup> These packages can then be transported and either sold to markets for fresh consumption or can be used for further industrial processing – either under vacuum or can-based.

## ADVANTAGE OF THIS NOVEL PROCESSING METHOD

The biggest advantage of this process is that it can preserve the shoot close to the place of harvesting without the need of low storage temperatures or by using preservatives. This protects the fresh shoots from degradation that could occur if they were to be kept outside under unhygienic environment. It must be noted that bamboo grows under high humidity, varying temperature conditions (15-35 °C) and this kind of environment encourages microbial degradation. Since the processed shoots stay preserved for multiple days, this gives the processors to sell their products to far off places or to take to processing facilities.

Other studies have worked on minimal processing of bamboo shoots. Low temperature and packaging have been used to reduce transpiration losses occurring in bamboo shoots stored in the open and at prevalent temperatures (which can range from 20-30 °C). Discoloration is the major cause of quality loss of shoots.<sup>13</sup> Fungicides have also been suggested to preserve their shelf life. Wang and He reported that addition of fungicide to bamboo shoots packaged in polyethylene film extended their shelf life to 62 days at 0 °C.<sup>14</sup> Kleinhenz et al attempted a combination of different packaging and low temperatures to increase the shelf life of bamboo shoots – polyvinyl chloride (PVC) gave the best results followed by low-density polyethylene (LDPE) and then microperforated LDPE. They were able to get a shelf life of 28 days when kept at 1-2 °C.<sup>13</sup>

## CONCLUSION

We believe that this technology can be used to preserve bamboo shoots and can minimize the post-harvest losses, as well as effectively exploit bamboo shoot sector in India, leading to an increase in production and hence export of processed bamboo shoots. This processing does not require refrigeration or cold chain hence it is successful for use in areas where only minimal facilities are available – thus, this processing can be of use in forest areas where bamboo shoots are commonly harvested from.

## CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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