



Processing of Bamboo

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Bamboo is a type of woody perennial grass that is part of the Poaceae family, commonly found in tropical and sub-tropical areas around the globe. There are over 1250 known species of bamboo, categorized into 75 different genera.¹ Among these, 125 species are present in India, of which only 30 hold commercial significance. Bamboos are crucial to the daily lives of rural communities, particularly in tribal regions. They serve as a substitute for wood, are utilized in the production of industrial goods such as charcoal, and are employed in various structural applications due to their remarkable strength (Ting, et al).

The bamboo plant is classified as a large species of grass. The bamboo shoot represents the fresh, tender growth of a young culm that emerges from the apex of the rhizome, characterized by its compressed internodes, which are safeguarded by multiple leathery sheaths. Thus, it refers to the young, developing culm of the bamboo plant.

The natural distribution of bamboo primarily spans the tropical, subtropical, and mild temperate zones 1,250 species classified under 75 genera worldwide; notably, India is home to more than 125 species across 23 genera. In terms of bamboo species diversity, India ranks as the third largest country, following China, which has 300 species, and Japan, with 237 species. The shooting period of bamboo varies among species. Generally, it is understood that runners, which are bamboos from temperate climates, tend to shoot in the spring, while clumpers, found in tropical and subtropical regions, typically shoot in late summer and fall. Examples of bamboo species found in the North Eastern region of India include *Bambusa balcooa*, *B. tulda*, *Dendrocalamus hamiltonii*, *D. giganteus*, and *Malocanna bacciferra* (Adier, Maria Fe V., et al).

The edible portion is comprised of meristematic cell tissue characterized by areas of rapid cell division and differentiation, which is surrounded by protective, inedible leaf sheaths. The entire bamboo shoot is divided into three components: the sheath, the tender bamboo shoot (tip), and the basal bamboo shoot. Bamboo shoots are exceptionally nutritious and serve as an excellent source of dietary fibers, carbohydrates, antioxidants, amino acids, minerals, vitamins, and protein, while being low in calories and fat content, yet abundant in essential fatty acids with health-promoting properties. The health-promoting attributes of bamboo shoots include anti-inflammatory, anticancer, antibacterial, antifungal, and antiviral effects, among others. Additionally, some anti-nutrients can be found in bamboo shoots. Notably, it is a traditional delicacy in various northeastern states of India. Bamboo shoots are utilized in the preparation of pickles, fermented products, biscuits, and canned goods, among other items (Ahmad, Zishan, et al).

Selection of raw material and cultivar

Selection of Raw Materials

The shooting period for sympodial bamboos spans from May to October, with the peak production occurring between July and August. Bamboo shoots should be chosen for consumption prior to becoming tough and must be free from diseases, insect damage, or any mechanical injuries both before and after harvesting. Bamboo shoots can be harvested at

various ages depending on the intended processing of different products; however, they are typically collected in June and July when the shoots reach a height of 30 cm. For instance, in the case of preparing fermented dry bamboo shoot products, shoots that are approximately 1.3 to 1.5 m in height are selected. Generally, shoots that are 30 cm tall are preferred for processing. Different species exhibit variations in nutritional composition based on the age at which they are harvested. For example, research indicates that the optimal harvesting age for the shoots of *D. asper*, *D. strictus*, and *B. tulda* is 10 to 14 days, 6 to 10 days, and 10 to 16 days after emergence from the ground, respectively. The edible portion of the bamboo shoot consists of meristematic cell tissue characterized by regions of rapid cell division and differentiation. Additionally, the bamboo shoot is encased in protective, non-edible leafy sheaths (Chaudhary, Unnati, et al.).

Cultivar/Variety

The bamboo species that thrive in temperate climates are referred to as runners, which produce shoots during the spring season. In contrast, the bamboo species found in tropical and subtropical regions are known as clumpers, which generate shoots in late summer and autumn. When it comes to cultivation, fresh bamboo seeds are not readily accessible. Consequently, bamboo is primarily propagated vegetatively by cutting the culm into one or two nodes, along with the culm buds, and placing them upright horizontally at an angle that varies according to the species, in warm and moist conditions. Although there are numerous varieties of bamboo shoot species present globally, not all of them are suitable for consumption. Some of the edible bamboo shoot species include *Dendrocalamus strictus*, *Bambusa bambos*, *Bambusa nutans*, *Bambusa tulda*, and *Dendrocalamus giganteus* (Chen, Chaoji, et al.).

Harvesting of bamboo for value addition

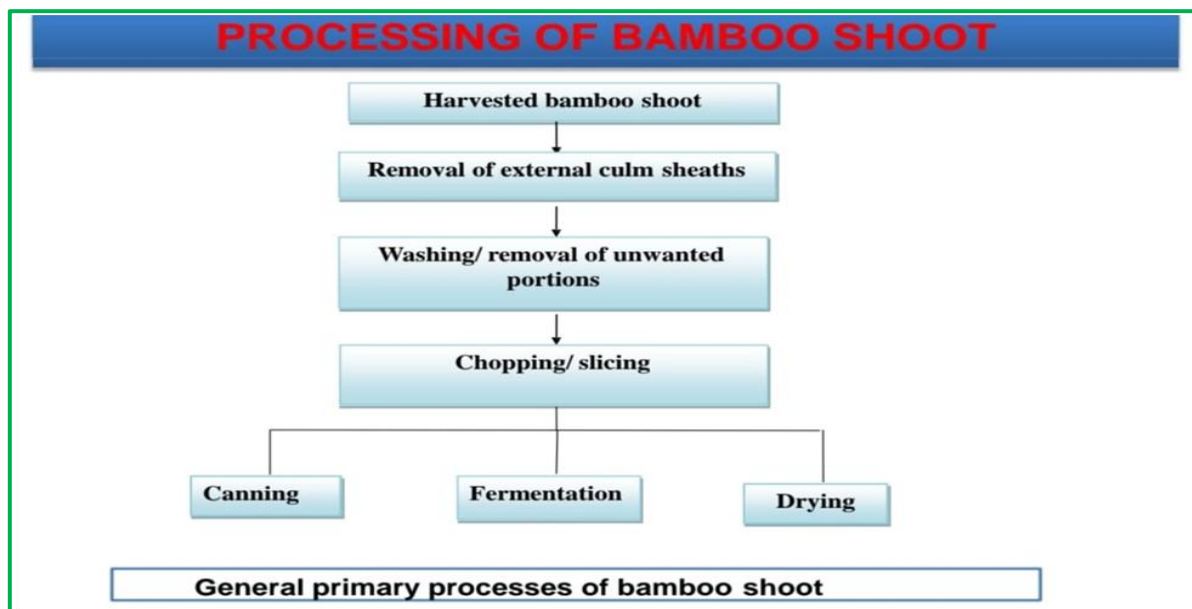
Harvesting bamboo for value addition necessitates a careful equilibrium between biological timing and mechanical technique to guarantee that the raw material remains both durable and workable. The process initiates with the identification of culms that have attained physiological maturity, which typically occurs between three to five years, as younger poles possess excessive moisture and starch that can lead to fungal decay and pest infestations.

To further reduce starch content—the primary food source for powder-post beetles—harvesting is optimally performed during the plant's dormant season or in the early morning hours prior to photosynthesis triggering sap flow. During the cutting process, workers must employ sharp tools to avoid splitting the base and should ideally make the cut just above the first or second node to safeguard the remaining rhizome system. Once felled, the poles are frequently left to "field dry" while leaning against standing bamboo; this initial transpiration aids in reducing weight and prevents the rapid shrinkage that can result in surface cracking. By meticulously managing these harvesting variables, the bamboo maintains the structural integrity and fiber density essential for high-value applications such as laminated flooring, furniture, and engineered structural beams (Dungani, R., et al.).

Post harvest treatment of bamboo shoots

Following the harvesting process, bamboo shoots can undergo rapid degradation due to various chemical transformations, enzymatic breakdown, and microbial spoilage. Additionally, bamboo shoots contain antinutrients, specifically cyanide, which must be eliminated prior to consumption.

- It is essential to implement certain pretreatments to remove the bitterness and cyanide from bamboo shoots before engaging in any specific consumption methods. Various internal and external factors, including enzymes, moisture content of the bamboo shoots, storage conditions such as temperature, the presence of microorganisms, and the storage methods employed, can significantly influence both the nutritional value and shelf life of bamboo shoots. In this context, processing plays a crucial role in preserving their quality (Guo, Wenwen, et al.).



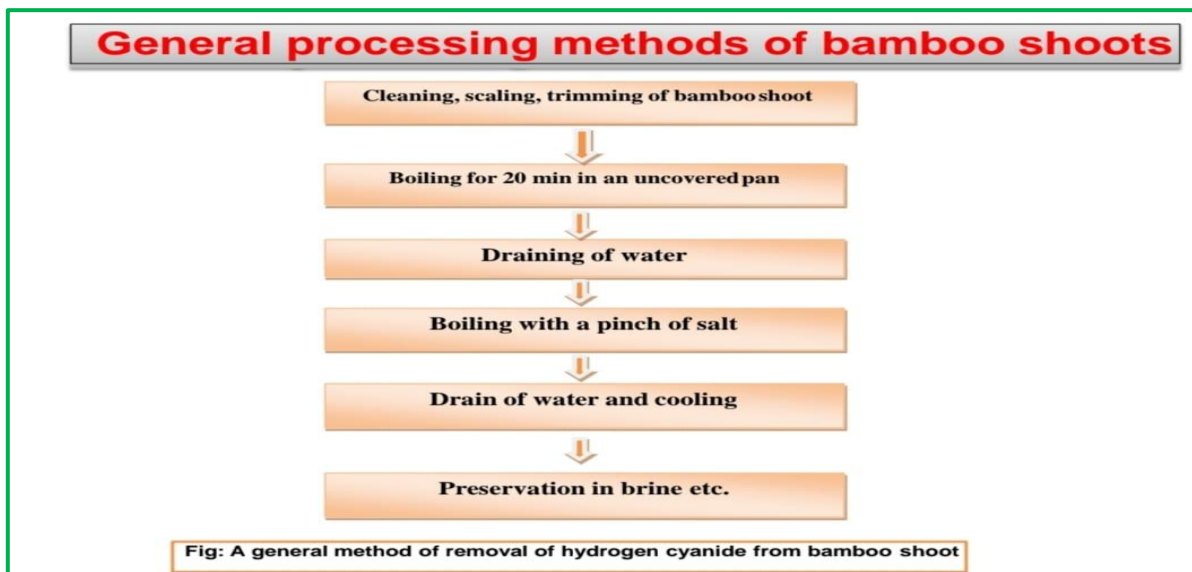
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General processing methods of bamboo shoots

Cleaning, peeling, and cutting bamboo shoots: Following the harvest, the bamboo shoot is cleaned to eliminate soil and other impurities. For subsequent processing, it is necessary to remove the outer scaly layers until reaching the tender edible core. The soft inner core of the bamboo shoot can be cut either longitudinally or perpendicularly according to our needs. In other terms, it is chopped and sliced (Huang, Bin, et al.).

Pretreatment:

Prior to the consumption of bamboo shoots, pretreatments are crucial due to the presence of certain antinutritional factors, including Cyanoglycosides (Taxiphyllin). The ingestion of cyanide can lead to various health issues such as general malaise, diarrhea, goiter, muscle weakness, and other complications affecting the respiratory, nervous, and gastrointestinal systems. Various methods for the removal of antinutrients include boiling, blanching, steaming, and soaking in water, among others. In Arunachal Pradesh, the local population employs banana leaves to semi-ferment bamboo shoots, which are then pressed with stones and placed near a water stream for a duration of 3-4 months. This process effectively eliminates the bitterness (Kalali, E., et al.).



Source: National Institute of Food Technology Entrepreneurship and Management
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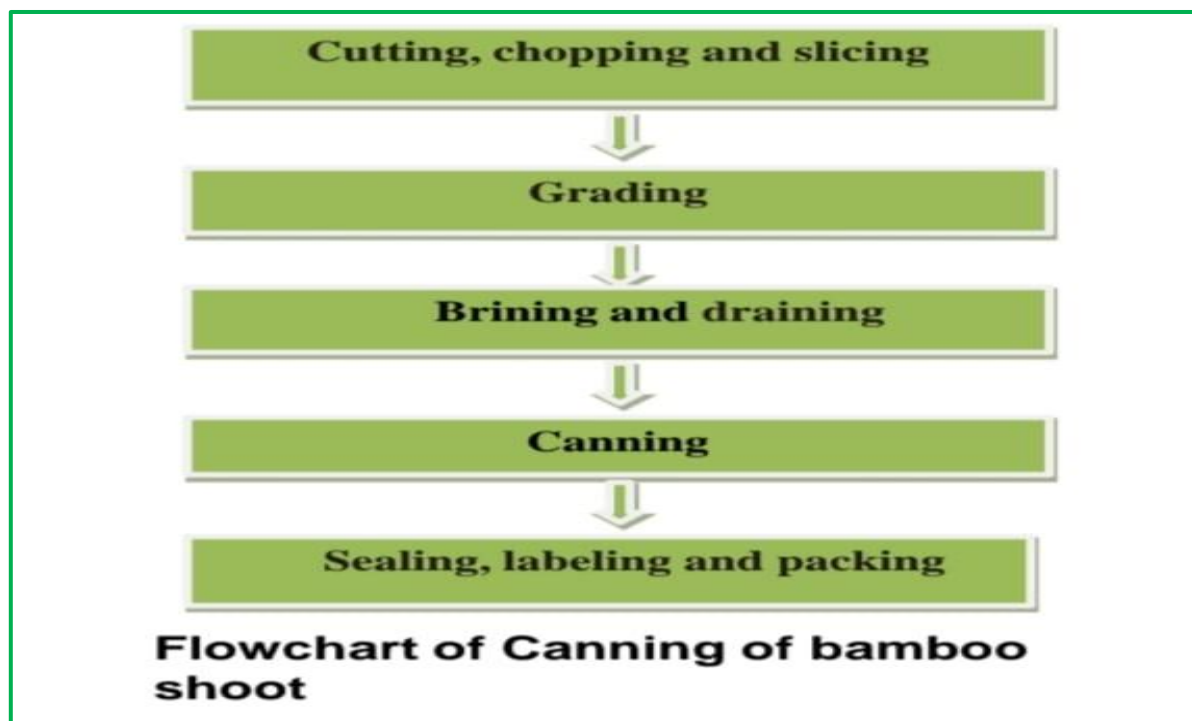
Processing of bamboo shoots:

The methods employed for processing are primarily aimed at preserving bamboo shoots, enabling their use over an extended period. Various techniques for processing bamboo shoots include fermentation, roasting, boiling, blanching, pickling, and canning, among others. In other terms, the preservation techniques for bamboo shoots encompass storage in a brine solution (for instance, 5% salt and 1% citric acid in 100 ml), drying, osmotic dehydration, fermentation, canning, pickling, freezing, or heating, etc. (Kelkar, B., et al.).

Drying:

Various drying techniques commonly employed include sun drying, oven drying, freeze drying, superheated steam drying, hot air drying, and vacuum freeze drying (FD), among others. Some studies have explored optimized advanced drying methods, such as utilizing a cabinet dryer at 60 °C for 7 to 8 hours, and a two-stage hybrid drying approach: hot airflow drying followed by vacuum freeze drying (AFD), as well as the reverse process, which involves vacuum freeze drying followed by hot airflow drying (FAD) (Khajouei-Nezhad, Mohammad, et al.).

Refrigeration: Regarding refrigeration, bamboo shoots can typically be stored for up to 2 weeks.



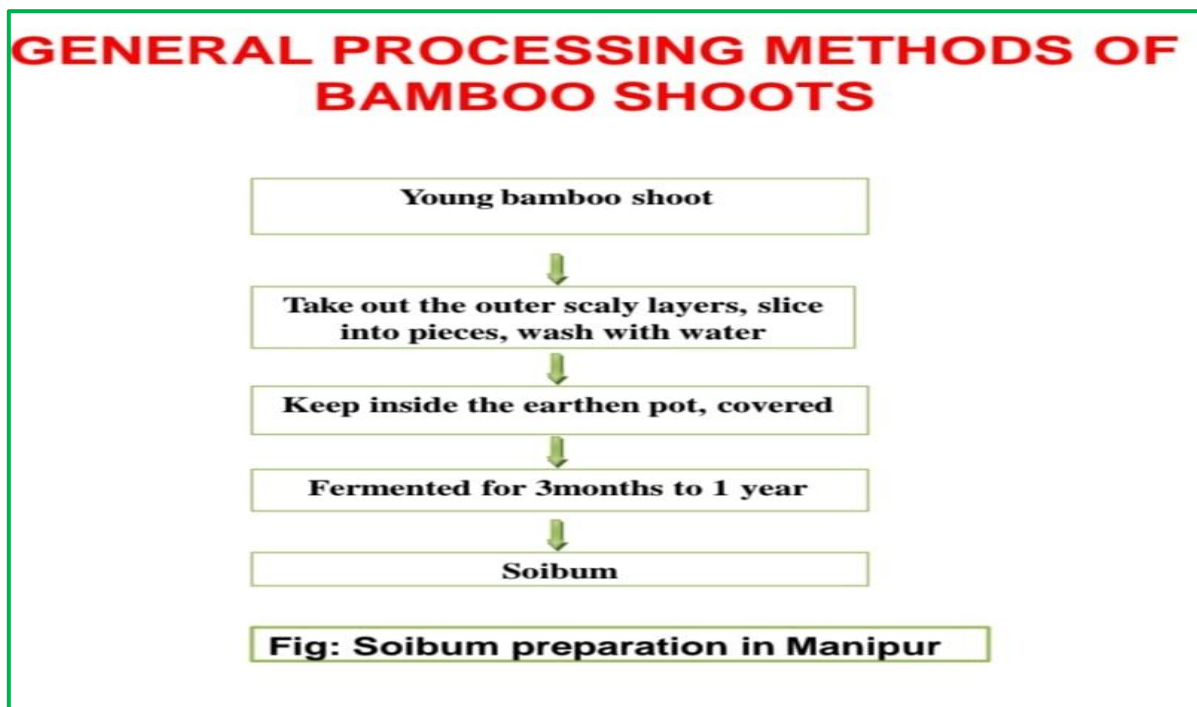
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Once the bamboo shoot is harvested, it is trimmed from both ends and the outer undesirable layers are removed. Subsequently, the tender bamboo shoot is washed with water, then chopped or sliced, followed by grading. The bamboo shoot pieces undergo boiling (brining), are drained, and then placed in cans. In these cans, salt solutions are incorporated and allowed to evaporate. Ultimately, the cans are sealed and processed (retort, 100-120 °C). After the cans have cooled, they are labeled and packaged. The canning and retort input-output ratio is approximately 100:85, with a processing time of around 2 days (Li, Zhihan, et al.).

Fermentation:

Fermentation is a widely used technique for the preservation of bamboo shoots. Various communities in India have their own unique methods for fermenting bamboo shoots. In Manipur, the fermented bamboo shoot is referred to as Soidon, Soibum, and Soijim (Lian, Hong, et al.).

SOIBUM: Soibum is a well-known fermented bamboo shoot product. It can be made using two different methods: the Khongkhang/Kwatha type and the Andro type (Lou, Z., et al.).



Source: National Institute of Food Technology Entrepreneurship and Management
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Soibum can be made using either a single type of bamboo shoot or a combination of different bamboo species. Typically, *D. hamiltonii* and *B. manipureana* are utilized in the production of soibum. The androtype soibum has a subtle aroma and a mild flavor. Initially, the outer unwanted sheaths of the chosen bamboo are removed, and the tender bamboo shoots are sliced and rinsed. Next, the sliced bamboo shoots are placed in an earthen pot and covered properly. This mixture is left to ferment for a duration of 3 months to 1 year (Sharma, Bhavna, et al.).

Soidon is made from the tip of fully grown bamboo shoots. After harvesting the tip of a mature bamboo shoot, the outer layers and lower sections are discarded. Following the addition of water to a container or earthenware pot, the cut tips sliced both across and lengthwise to a depth of 4-5 cm are submerged in the water, along with a portion of fermented liquid (soijim) from a prior batch. Cover it now and allow it to ferment at room temperature for 3-7 days. Adding leaves of *Garcinia penduculata* to the pot can further improve the flavor. Once fermentation is complete, the soidon can be transferred to an airtight container and stored at room temperature for up to a year (Silva, Marcos F., et al.).

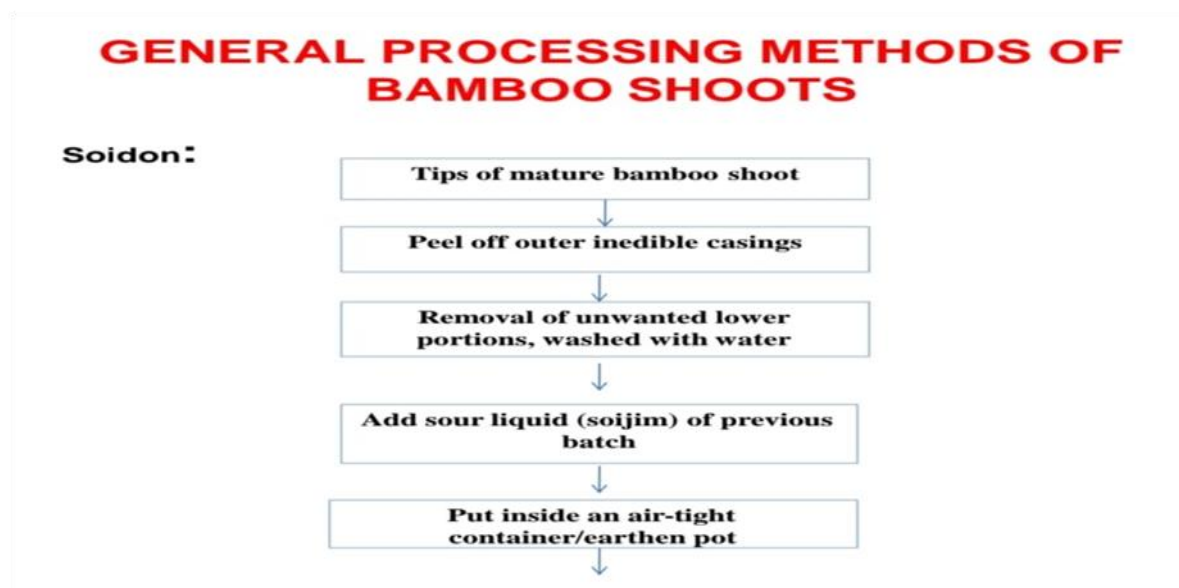


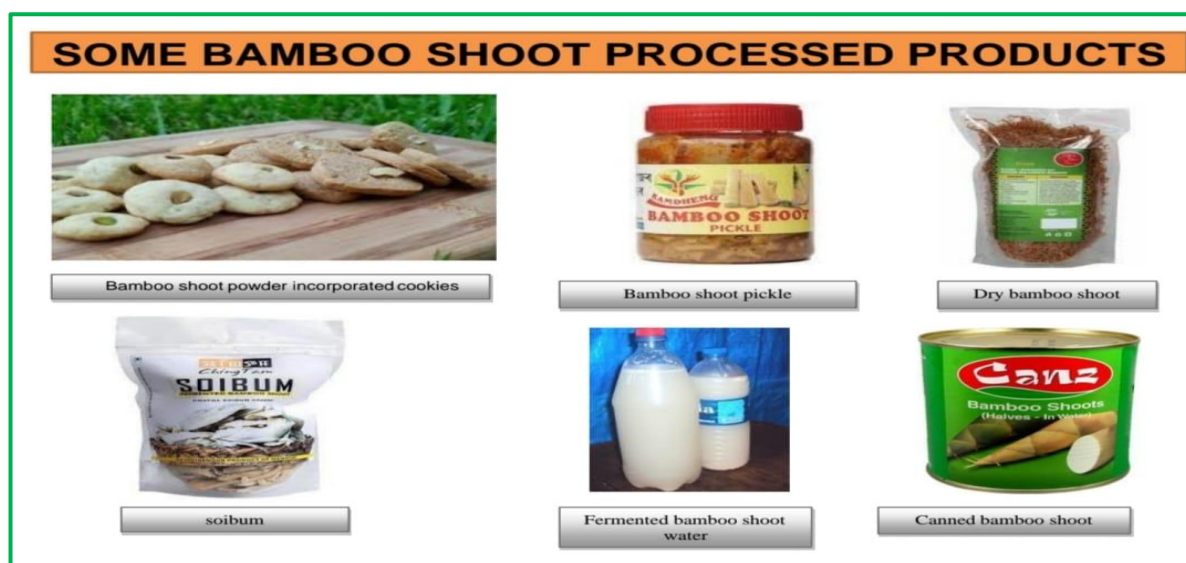


Fig: Soidon preparation in Manipur

Source: National Institute of Food Technology Entrepreneurship and Management
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By product processing

Approximately 70% of harvested bamboo shoots are currently being discarded as waste, including outer sheaths, basal sections, and wastewater. Research revealed that byproducts of bamboo shoots, including the outer sheaths and tough bases, contain antioxidant activity, bioactive compounds, and cyanide, similar to the tender shoots themselves. Therefore, these BSPR may be useful for extracting bioactive compounds. Additional research is necessary to explore effective methods for removing the toxic cyanogenic compounds from BSPR while preserving its beneficial nutrients and bioactive compounds, ensuring the safety of BSPR extract for use (Yusuf, S., et al.).



Conclusion

Bamboo shoots offer significant economic opportunities through farming, processing, packaging, and sales. Currently, standardized processes and technologies for bamboo shoot products are lacking, and most offerings remain traditional, locally produced, and unstructured, reflecting established regional preferences. There is significant potential to develop standardized processes and technologies for creating products from bamboo shoots, or for preserving raw bamboo shoots into a variety of food items through organized methods (Zheng, Zhiyu, et al.).

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