Traditional fermented bamboo shoot foods of North-East India and their characteristic natural microbial flora

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- The Bamboos are versatile multipurpose forest tree grasses.
- They are one of the most economically important plants in the world (Lewington,1990).
- Bamboos are also highly popular as healthy food items.
- The consumption of fermented bamboo shoots in India is confined mostly to the North-Eastern states.
- Fermented bamboo shoot products constitute important diets of the locals.
- *Soibum, soidon, soijim, bastangapani*, *mesu, eup, ekung* etc. are popular fermented bamboo shoot foods of North-East India .
- The fermented bamboo shoot preparation is a tradition and needs to be safeguarded.

- There is a of displacing important traditional foods due to introduction of western foods (FAO, 1998).
- Host of microbes mainly lactic acid bacteria are involved in bamboo shoot fermentation.
- This results not only in enhancement of flavour, taste and aroma but also detoxification of anti-nutrients present in bamboo shoots.
- The present article highlights the different traditional methods of fermented bamboo shoot production in North-East India and their microbial populations contributing desirable functional and technological attributes.

Fermented bamboo shoot products of North-East India

- The North-East India comprises of eight states viz., Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Arunachal Pradesh and Tripura.
- The region is home to different ethnic communities with diverse cultural and religious beliefs.
- The region covering an area of around 18.4 million hectares.
- It is considered as a treasure house of bamboos contributing more than 66% of bamboo species of India (Sarmah et al. 2000).
- Different fermented bamboo shoot products are assigned indigenous names based on ethnic communities consuming it, nature of products and their mode of preparation.

Map of India

Map of North- East India

Different tribes of Manipur

Aao Tribe of Nagaland

Bodo of Assam

Tribes of Mizoram

Khasi of Meghalaya

Gorkha of Sikkim

Tribes of Arunachal Pradesh

Tribe of Tripura

Fermented bamboo shoot	Nature of product	Uses	Community	NE States of India
Mesu	Solid, acidic, sour taste	Use as pickle	Gorkha	Sikkim
Soibum	Wet, solid, sour taste	Use in the preparation of special local dish called Iromba or cooked with fish and meat	Meetei	Manipur
Soidon	Wet, solid, sour taste	Use in making of Iromba or consumed as vegetable with fish or meat	Meetei	Manipur
Soijim	Liquid, acidic, sour taste	Use as condiment and flavouring agent	Meetei	Manipur
Bastangapani	Liquid, acidic, sour taste	Use as condiment and flavouring agent	Nagas	Nagaland
Ekhung	Solid, sour and acidic	Use in the preparation of local dishes, curry or soups	Adi tribe	Arunachal Pradesh
Hirring	Solid, Sour, acidic taste	Preparation of local dishes	Nishi tribe	Arunachal Pradesh
Eup	Solid, sour, acidic	Preparation of ethnic dishes	Nishi	Arunachal Pradesh
Tuaithar	Wet, solid and sour taste	Use as pickle or in the making of traditional curry	Baite, Hmar	Mizoram, Manipur
Lung-SieJ	Wet, sour , acidic	Used in the preparation of traditional curry	Khasi	Meghalaya

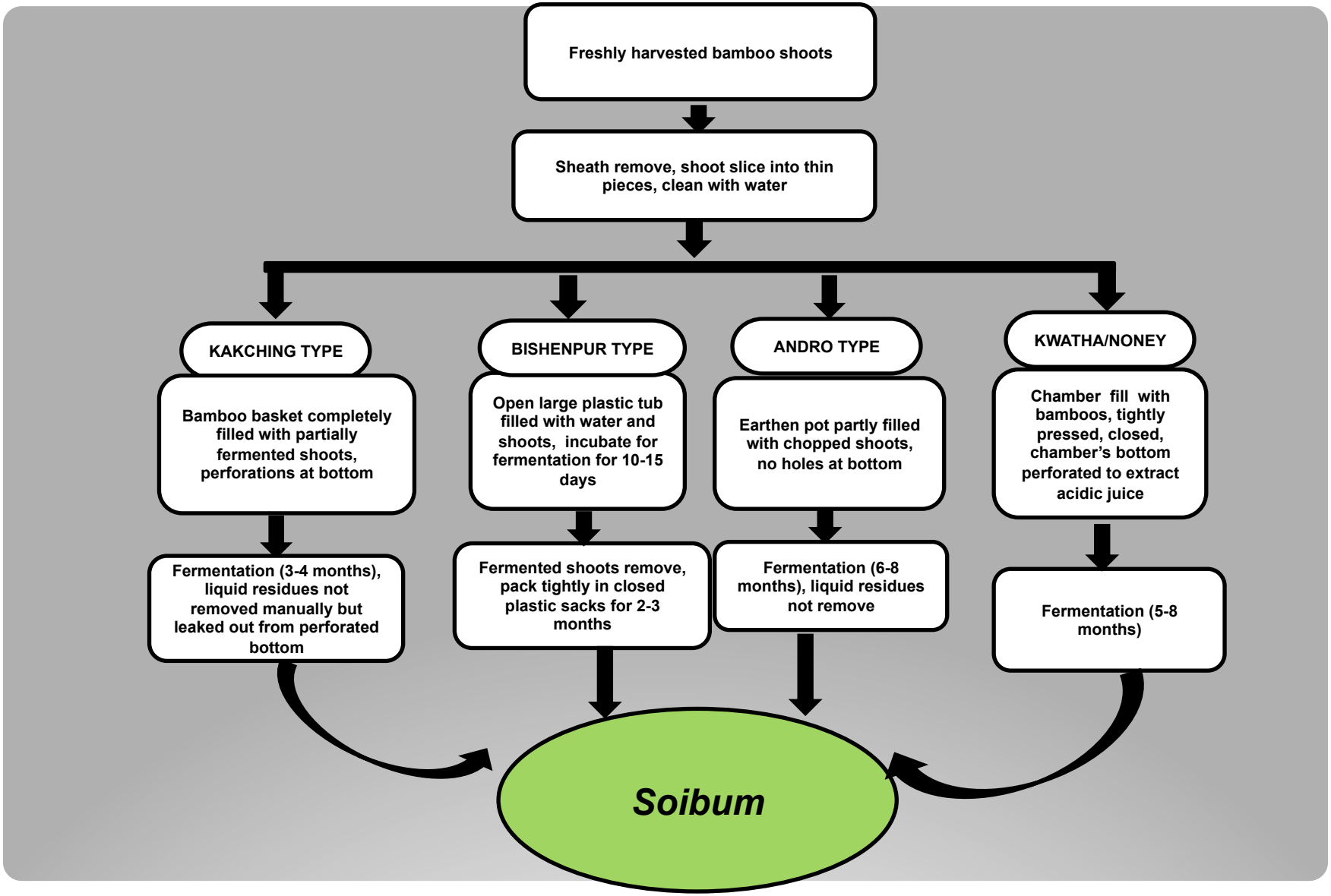

Figure: Production of different *soibum* varieties

Figure: Production of Kakching *soibum*

Figure: Production of Bishenpur *soibum*

Figure: Earthen pot filled with bamboo shoots (Andro *soibum* preparation)

Soft apical stems
apical stems

Young tender stems of *Teinostachyum wightii* and soft apical stems of *D. hamiltonii, D. giganteus* collected

Hard inedible sheaths removed and cleaned properly with water

Sliced stem pieces/ shoot tips submerged in container with water

Sour liquid obtained from the previous batch added , leaves of *Garcinia pedunculata* may be added

Container tightly closed and allowed to ferment for 9-10 days and fermented products- *Soidon* removed

Soidon prepared from apical stem of *D. hamiltonii* & *D. giganteus*

Naat based Soidon

Figure: Production of *Soidon*

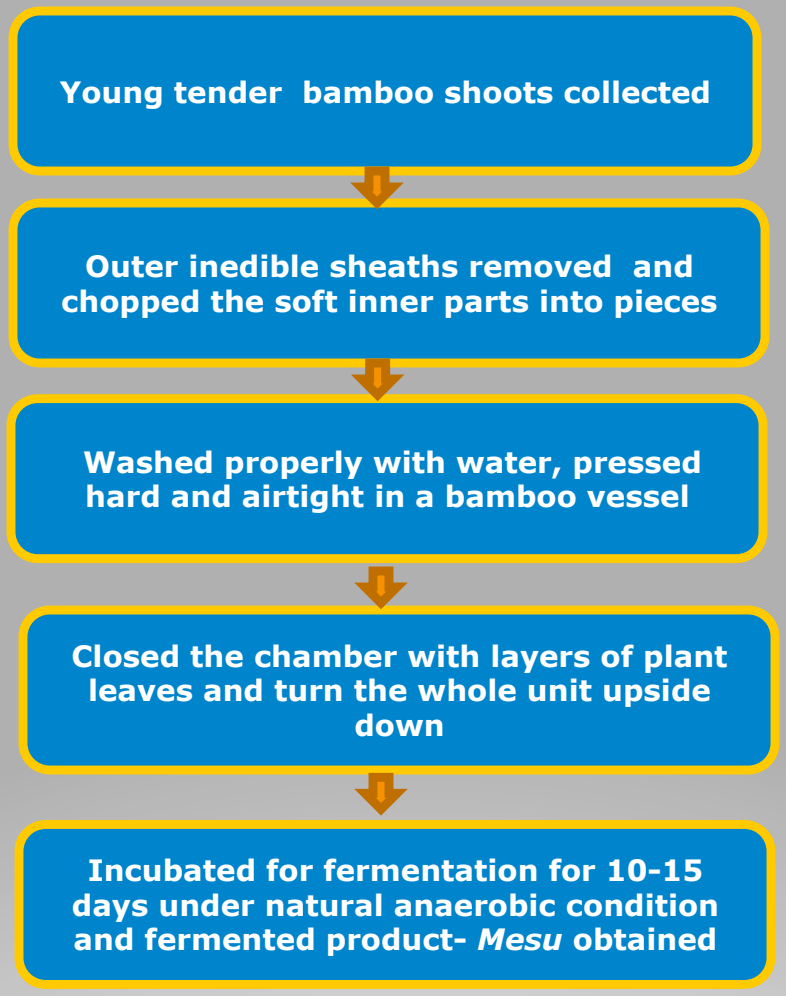

Figure: Production of *Mesu*

Bamboo shoots collected, chopped after outer sheaths removed and washed with water

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Pit dug and bamboo shoot filled bamboo basket placed inside it

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Basket closed and pit covered with layers of leaves and soil, heavy objects put on it

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Ferment for 2-3 months and basket open to collect the fermented product- ***Ekhung***

Ekhung

Figure: Production of *Ekhung*

Fermented bamboo liquid

- The sour acidic liquid called "*soijim*" produced during bamboo fermentation can be used as condiment.
- In Arunachal Pradesh, the juice drained from fermented bamboo shoots is called *eku* which is popularly used as flavouring agent.
- In Nagaland, the liquid portion can also be extracted from fermented shoots.
- This fermented bamboo liquid is locally called *banstangapani* and forms an indispensable part of daily cuisine of Nagas.
- Liquid portion collected is packed in plastic bottles and sold in local markets.

Fermented bamboo liquid

- The production of traditional fermented bamboo shoot products involves natural process of fermentation by lactic acid bacteria.
- LAB (Lactic Acid Bacteria) produce lactic acid as major end product through carbohydrate fermentation.
- It results in the development of flavor, aroma and characteristic sour taste of the fermented products.
- LAB present in fermented shoot product contribute different functional and technological attributes.
- Removal of anti–nutritive factor is important functional property of LAB.

- Phytic acid is an antinutritive factor present in fermented bamboo shoots.
- It forms an insoluble complex with calcium, zinc, iron and copper interfering their absorption.
- Phytic acid degradation by *L. brevis* was found to be highest in *soibum* .
- High phytase activity was also shown by *L.curvatus*, *L. xylosus* and *L plantarum* in *soidon, eup* and *hirring* (Sonar and Halami, 2014).

Sample	Isolates	Phytase activity (U^{-l} ml)
Soibum	***L. brevis***	**19.33**
	L.plantarum	14.78
	Lactobacillus sp.	13.81
Soidon	*L.curvatus*	14.67
Eup	*L.xylosus*	13.42
Hirring	*L.plantarum*	11.94

).

- The ability of LAB in lowering the pH of the substrate is important functional attributes .
- Tamang and Tamang (2009) found *L. plantarum* from *ekhung* having the low value of pH 3.9.
- Sonar and Halami (2014) also identified strains of *L. plantarum* isolated from *Soibum, hecche* and *hirring* producing highest acidification (less than 4 pH values).

Sample	Isolates	Acidification
Ekhung	***L.plantarum***	**3.90**
Soibum	*L. brevis*	4.70
	L.plantarum	**3.90**
	L. fermentum.	4.38
Hecche	*Leuconostoc sp.*	4.87
	L.plantarum	**3.75**
Hirring	***L.plantarum***	**3.98**

- The production of lactic acid by LAB inhabiting the fermented food reduces the pH to such level that the pathogenic bacteria if present in the food are either inhibited or killed (Halzaptel et al.1995).

- **High hydrophobicity is the indication that the bacterial culture is able to adhere into the epithelial cell layer of digestive tract for efficient colonization (Holzapfel et al. 2002).**
- **LAB isolated from *soibum* such as *L.plantarum and L.brevis* exhibited high degree of hydrophobicity ..**

Sample	Isolates	% Hydrophobicity
Soibum	***L. brevis***	**70.47**
	L.plantarum	**93.48**
	L. fermentum.	59.81
Soidon	*L. curvatus sp.*	40.58
Hirring	*L.plantarum*	55.91
	L. lactis	59.50
Ekhung	*T. halophilus*	67.70

Table: Microbial content of some popular traditional fermented bamboo shoot products

Fermented shoot product	Microorganism present	Country	References
Mesu	Lactobacillus plantarum, Enterococcus faecium, Lactococcus lactis	India, Nepal	Tamang and Sarkar, 1994; Das and Deka, 2012
Soibum	Lactobacillus brevis, L. plantarum, Leuconostoc mesenteroides, L. fallax	India	Sonar and Halami, 2014; Das and Deka, 2012; Tamang et al., 2008
Soidon	Lactobacillus brevis, L. lactis, L.curvatus, Leuconostoc fallax		Sonar and Halami, 2014; Das and Deka, 2012; Tamang et al., 2008
Soijim	Lactobacillus brevis, Leuconostoc lactis, L. fallax, L. mesenteroides	India	Tamang et al., 2008
Ekung	Lactobacillus plantarum, L.brevis, L. casei, L. fermentum, Tetragenococcus halophiles	India	Das and Deka, 2012; Tamang and Tamang., 2009
Heccha	Lactobacillus plantarum, Leuconostoc sp.	India	Sonar and Halami, 2014
Eup	Lactobacillus brevis, L. plantarum, L. xylosus, L. casei, L. fermentum, Leuconostoc mesenteroides, L. fallax	India	Sonar and Halami, 2014; Tamang et al., 2012; Tamang et al., 2008
Hirring	Lactobacillus brevis, L. plantarum, L.curvatus, L. lactis	India	Sonar and Halami, 2014; Das and Deka, 2012; Tamang et al., 2008
Lung-seij	Lactobacillus brevis, L.curvatus, Leuconostoc mesenteroides, L. fallax, L. lactis, L. citreus	India	Tamang et al., 2008
Tuaithur	Lactobacillus brevis, L.curvatus, L.plantarum, Bacillus circulans, B. firmus, B. sphaericus, B. subtilis	India	Tamang et al., 2012
Soidonmahi	Bacillus subtilis, B. cereus, B. pumilus, Lactobacillus brevis, L. plantarum, Enterococcus faecium	India	Jeyram et al., 2010
Tabah bam shoot pickle	Lactobacillus plantarum, L. brevis	Indonesia	Darmayanti et al., 2014
Naw-maidong	Lactobacillus buchneri L.plantarum, L.brevis, L. fermentum	Thailand	Tanasupawat and Komagata, 1995
Jiang-sun	Lactobacillus plantarum, Lactococcus lactis,	Taiwan	Chen et al., 2010

CONCLUSION

- The production of fermented bamboo foods is generally traditional and meant largely for local markets.
- Improvement of fermented bamboo shoot production can be achieved by employing modern scientific techniques.
- Extensive investigation on microbial biodiversity is required to understand the safety aspect of the food.
- Improvisation of fermented shoot production with scientific inputs combined with detailed studies on microbial biodiversity for their characteristic functional and technological properties will help in accelerating the production of safe fermented bamboo shoots in larger scale.

Thank You