

## Traditional knowledge of biopreservation of perishable vegetable and bamboo shoots in Northeast India as food resources

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Biopreservation of perishable vegetables is a native skill of Northeast Indian women. Lactic acid fermentation is the actual mechanism involve in the biopreservation process of perishable vegetable and bamboo shoots. Some ethnic fermented vegetables of Northeast India are *gundruk*, *sinki*, *goyang*, *inziangsang*, *khalpi*, *anishi*, etc. and ethnic fermented bamboo shoot products are *mesu*, *soidon*, *soibum*, *soijim*, *ekung*, *eup*, *hiring*, and *lung-siej*.

**Keywords:** Ethnic fermented vegetables, Biopreservation, LAB, Gundruk, Sinki, Goyang, Khalpi, Inziangsang, Mesu, Soidon, Soibum, Soijim, Ekung, Eup, Hirling, Lung-siej, Anishi, Northeast India

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Perishable vegetables are grown in smaller and larger terraces in the hilly slopes from sub-tropical to temperate regions in Northeast India<sup>1</sup>. About 19 genera with more than 78 species of indigenous and exotic varieties of bamboo are grown in the biodiversity-rich regions of Northeast India<sup>2</sup>. Annually, about 26.2 tons, 435 tons and 426.8 tons of bamboo shoots are harvested in Sikkim, Meghalaya and Mizoram states, respectively<sup>3</sup>. Biopreservation refers to extended storage life and enhanced safety of foods using the natural microflora and their antibacterial products<sup>4</sup>. The women communities of different ethnic groups of Northeast India have been practicing the lactic fermentation process to preserve the perishable and seasonal vegetables in absence of refrigeration and freezing. The preserved fermented vegetables are consumed in long monsoon season during which fresh leafy vegetables may not be available in plenty in the mountains regions. It transpires a distillation of knowledge and wisdom of women gained by experience and based on trial and error. The native women may not be able to explain the microbiology and biochemistry of vegetable fermentation, but they know how to provide favourable conditions for fermentation and thus to promote the beneficial microorganisms in getting the

desired fermented products<sup>5</sup>. Some ethnic fermented vegetable products of Northeast India are *gundruk*, *sinki*, *goyang*, *inziangsang*, *khalpi* and *anishi*, etc. and common ethnic fermented bamboo shoot products are *mesu*, *soidon*, *soibum*, *soijim*, *ekung*, *eup*, *hiring* and *lung-siej*.

### Gundruk

*Gundruk* is an ethnic fermented vegetable food of the *Nepali* living in the Himalayan regions of India, Nepal and Bhutan<sup>6</sup>. It is produced during winter when large quantities of leaves of mustard, *rayo-sag* (local variety of mustard), radish and other vegetables pile up. *Gundruk* is similar to fermented vegetable products of other countries such as *kimchi* of Korea, *sauerkraut* of Germany, *sunki* of Japan and *suan-cai* of China. Leaves of *rayo-sag* (*Brassicca rapa* sub-species *campestris* variety *cuneifolia*), mustard (*Brassicca juncea*), or cauliflower (*Brassicca oleracea* variety *botrytis*) are wilted and shredded are crushed mildly and pressed into an earthen jar or container. It is made air tight and fermented naturally for about 7-10 days. After 7-10 days, a mild acidic taste indicates the completion of the fermentation and *gundruk* is removed from the jar and is sun dried for 3-4 days to make it dry (Fig. 1). The dominant producer is the *Nepali* women. *Gundruk* is eaten as a soup or pickle. *Gundruk* soup is a good appetizer in a

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bland and starchy diet. It is sold in all local markets by rural women in Darjeeling hills and Sikkim for economy subsistence. *Lactobacillus (L) fermentum*, *L. plantarum*, *L. casei*, *L. casei* subsp *pseudoplantarum*, *Pediococcus pentosaceus* have been found in the samples<sup>7,8</sup>.

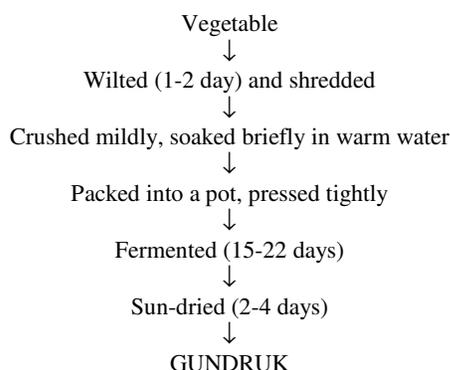


Fig. 1—Traditional method of gundruk preparation in Sikkim

### Sinki

*Sinki*, a fermented radish tap root product which is prepared by pit fermentation method. About 1 m pit of same diameter is dug in a dry place. The pit is cleaned, plastered with mud and warmed by burning. After removing the ashes, the pit is lined with bamboo sheaths and paddy straw. Radish tap-roots are wilted for 2-3 days, crushed, dipped in lukewarm water, squeezed and pressed tightly into the pit, then covered with dry leaves and weighted down by heavy planks or stones. The top of the pit is plastered with mud and left to ferment naturally for 22-30 days (Fig. 2). After completion of fermentation, fresh *sinki* is removed, cut into small pieces, sun-dried for 3-5 days, and stored at room temperature for future consumption. Dry *sinki* is kept for 2 yrs or more at room

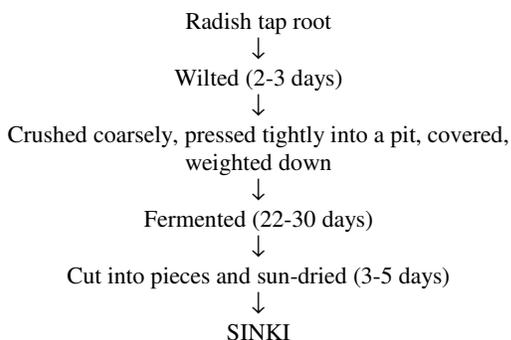


Fig. 2—Traditional method of *sinki* preparation in Darjeeling hills

temperature. The dominant producer is the *Nepali* women, supported by men. *Sinki*, with a highly acidic flavour, is typically used as a base for soup and as pickle. It is said to be a good appetizer, and people use it as a remedy for indigestion. *Sinki* is also sold in all local markets by the rural women for their livelihood. *Lactobacillus plantarum*, *L. brevis*, *L. casei*, *Leuconostoc fallax* have been found in the samples<sup>8,9</sup>.

### Goyang

*Goyang* is an ethnic fermented acidic vegetable food of *Sherpa* of Darjeeling hills and Sikkim. It is prepared during rainy season when the leaves of wild plant, *magane-saag (Cardamine macrophylla Willd.)* are plenty. Leaves of wild edible plant, *magane-saag* are collected, washed, cut into pieces, then squeezed to drain off excess water, and are tightly pressed into the bamboo baskets lined with 2-3 layers of leaves of fig plants. Top of the baskets are then covered with fig plant leaves, and fermented at room temperature (~15-25°C) for a month (Fig. 3). After completion of desired fermentation, fresh *goyang* is transferred into an air tight container which can be stored for 2-3 months. *Goyang* can be kept longer by making the freshly fermented *goyang* into balls and sun dry, which can be kept for several months. The dominant producer is the *Sherpa* women. *Goyang* is boiled in a soup along with yak or beef meat and noodles to make a thick *thukpa*, a common staple food of the *Sherpa*. It is generally prepared at home. *Lactobacillus plantarum*, *L. brevis*, *Lactococcus lactis*, *Enterococcus faecium*, *Pediococcus pentosaceus* have been found in the samples<sup>10</sup>.

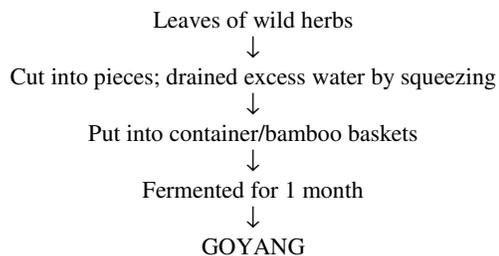


Fig. 3—Traditional method of *goyang* preparation in Sikkim

### Ziangsang

In ziangsang or ziangsang is a traditional fermented leafy vegetable product of Nagaland and Manipur mostly consumed by the Naga. It is very similar to gundruk. Leaves of mustard (hangam) are crushed and soaked in warm water. Leaves are then squeezed

to remove excess water and put into air tight container, and fermented at ambient temperature (~20-30°C) for 7-10 days (Fig. 4). Like gundruk, freshly prepared inziangsang is sun dried for 4-5 days and stored in a closed container for a year or more at room temperature for future consumption. Freshly fermented inziangsang juice is also extracted, instead of sun-drying, by squeezing with hand and concentrated by boiling. The liquid form of fermented extract is called ziang dui and the concentrated paste is ziang sang. Extract concentrate is stored in traditional bamboo container for a year. The dominant producer is the Naga women. Inziangsang is consumed as soup with boiled rice. Fermented extract ziang dui is used as condiment in meals. Inziangsang is sold in the local market in Manipur and Nagaland. *Lactobacillus plantarum*, *L. brevis*, *Pediococcus acidilactici* have been found in the samples<sup>8</sup>.

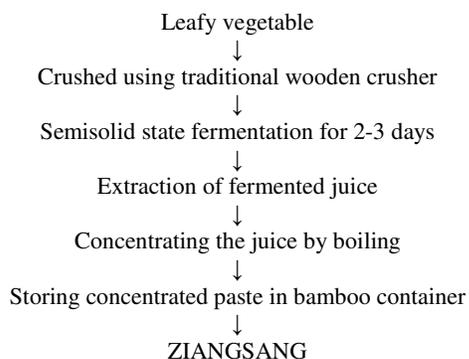


Fig. 4—Traditional method of ziangsang preparation in Manipur

### Khalpi

*Khalpi* is a traditional fermented cucumber product, consumed by the Brahmin *Nepali* in Darjeeling hills and Sikkim. Matured and ripened cucumber is cut into suitable pieces, sun dried for 2 days and then put into a bamboo vessel, locally called *dhungroo* and made air-tight. It is fermented at room temperature for 4-7 days (Fig. 5). *Khalpi* is kept in air tight container for a week at room temperature. Usually, 3-5 days old *khalpi* is preferred by the consumers. When kept for more than 5 days it becomes sourer in taste which is not preferred. The dominant producer is the *Nepali* women belong to *Bahun* and *Chettri* castes supported by men. *Khalpi* is consumed as pickle by adding mustard oil, salt and powdered chilies, in meal with the boiled rice. It is prepared for home consumption. *Lactobacillus plantarum*, *L. brevis*, *Leuconostoc fallax* have been found in the samples<sup>11</sup>.

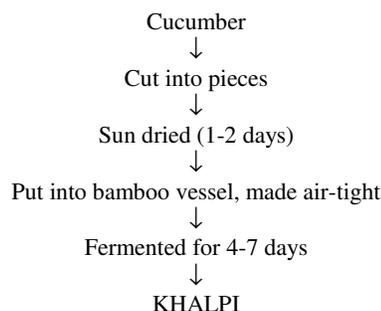


Fig. 5—Traditional method of *khalpi* preparation in Sikkim

### Mesu

*Mesu* is a traditional fermented bamboo shoot pickle with a sour-acidic taste of Darjeeling hills and Sikkim. Locally grown young edible shoots *choya bans* (*Dendrocalamus hamiltonii*), *karati bans* (*Bambusa tulda*) and *bhalu bans* (*Dendrocalamus sikkimensis*) are defoliated, chopped finely and pressed tightly into a green hollow bamboo stem. The tip of the vessel is covered tightly with leaves of bamboo or other wild plants and left to ferment under natural anaerobic conditions for 7-15 days (Fig. 6). Completion of fermentation is indicated by the typical *mesu* flavour and taste. The dominant producer of *mesu* is the *Limboo* women of ethnic *Nepali* community. *Mesu* is eaten as a pickle. *Mesu*-pickle is mixed with edible oil, chilies and salt and is kept in a closed jar for several months without refrigeration. *Mesu* kept in a green bamboo vessel, loosely capped by leaves of fig plant tied by straw is commonly is sold during rainy season in local markets of Darjeeling hills and Sikkim by the *Limboo* women. *Lactobacillus plantarum*, *L. brevis*, *L. curvatus*, *Leuconostoc citreum*, *Pediococcus pentosaceus* have been found in the samples<sup>12,13</sup>.

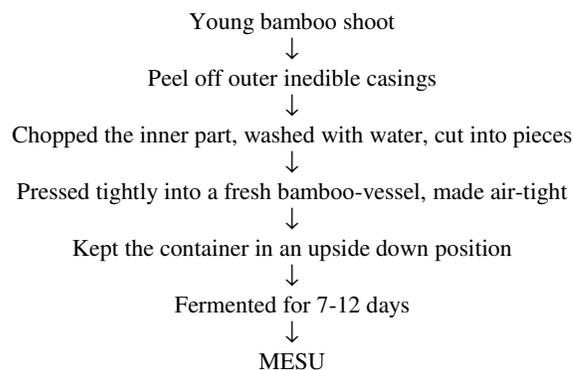


Fig. 6—*Mesu* preparation in Darjeeling hills

### Soibum

*Soibum* is an ethnic fermented bamboo shoot of Manipur. It is whitish in colour and with faint aroma and sour taste. *Soibum* is prepared from succulent bamboo shoots [*Dendrocalamus hamiltonii* (Wanap, Unap, Pecha), *D. sikkimensis* and *D. giganteus* (Maribop), *Melacona bambusoide* (Moubi/Muli), *Bambusa tulda* (Utang), *B. balcona* (Ching saniebi), etc.]. The outer casings of young shoots are removed, the inner part is sliced into pieces, washed and placed in a covered earthen pot and fermented for 3-12 months (Fig. 7). It can be prepared from the single species of bamboo or from intermixed of more than one species. The dominant producer is the *Meitei* women, supported by men. *Soibum* is usually consumed with steam rice as regular side dish by *Meitei*. *Soibum* is commonly sold in local vegetable markets exclusively by women in Manipur. *Lactobacillus plantarum*, *L. brevis*, *L. coryniformis*, *L. delbrueckii*, *Leuconostoc fallax*, *L. lactis*, *L. mesenteroides*, *Enterococcus durans*, *Streptococcus lactis*, *Bacillus subtilis*, *B. licheniformis*, *B. coagulans* and yeasts *Candida*, *Saccharomyces* & *Torulopsis* have been found in the samples<sup>13-15</sup>.

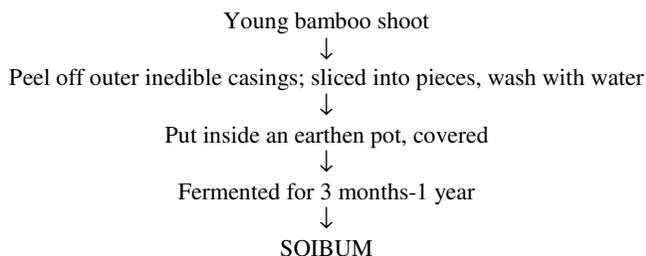


Fig. 7—*Soibum* preparation in Manipur

### Soidon

*Soidon* is a fermented tip of matured bamboo shoot product of Manipur. Tips of matured bamboo shoot (*Bambusa tulda* Roxb., *Dendrocalamus giganteus* Munro and *Melocana bambusoides* Trin.) are collected, outer casings and lower portions are removed. Whole tips are submerged in water in an earthen pot; sour liquid (*soijim*) of previous batch is added as starter in 1:1 dilution, covered and fermented for 3-7 days at room temperature (Fig. 8). Leaves of *Garcinia pedunculata* Roxb., locally called *heibung* in *Manipuri* language, may be added in the fermenting vessel during fermentation to enhance the flavour of *soidon*. After 3-7 days, fermented products,

now *soidon* are removed. *Soidon* can be kept in closed container at room temperature for a year. The dominant producer is the *Meitei* women, supported by men. *Soidon* is consumed as a curry as well as pickle. *Soijim* (liquid formed during fermentation of *soidon*) is used as condiment to supplement the sour-taste in curry in *Manipuri* dishes. *Soidon* is sold in the local market in Manipur by *Meitei* women. *Lactobacillus brevis*, *Leuconostoc fallax*, *L. lactis* have been found in the samples<sup>13</sup>.

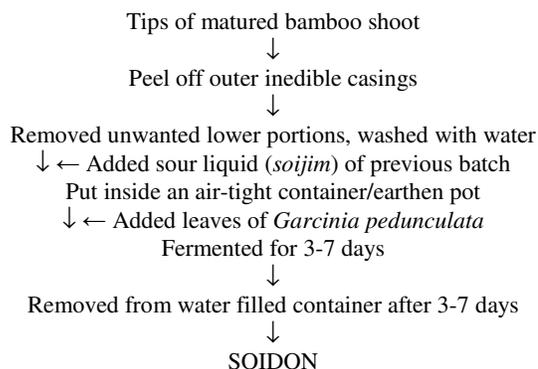


Fig. 8—*Soidon* preparation in Manipur

### Ekung

*Ekung* is an ethnic fermented bamboo tender shoot product of Arunachal Pradesh. It is prepared during mid April to early September when the young bamboo shoots are plenty. Young bamboo tender shoots (*Dendrocalamus hamiltonii* Nees. et Arn. ex Munro, *Bambusa balcooa* Roxb., *Dendrocalamus giganteus* Munro, *Phyllostachys assamica* Gamble ex Brandis, *Bambusa tulda* Roxb.) are collected and outer leaf sheaths are removed. The edible portions are chopped into very small pieces. Pit is dug in the

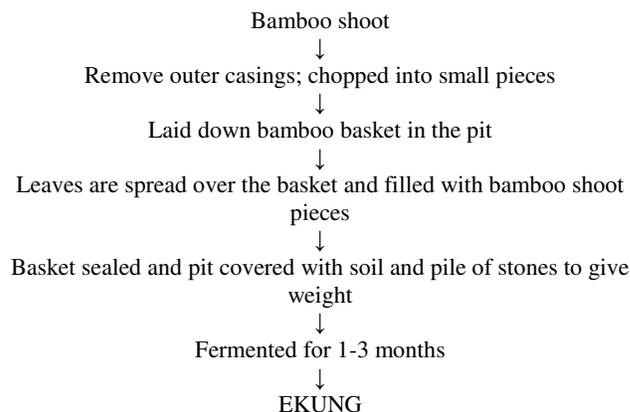


Fig. 9—Method of preparation of *ekung* in Arunachal Pradesh

forest usually in and around water source to facilitate washing of bamboo shoot pieces. The bamboo baskets are laid into the pit and lined with leaves. Chopped bamboo shoot pieces are put into the basket, covered with leaves and then sealed. Heavy stones are kept to give weight to drain excess water from the bamboo shoots and fermented for 1-3 months (Fig. 9). *Ekung* is kept for a year in an air tight container. The dominant producer is the *Nyishing* women, supported by men. *Ekung* is consumed raw or are cooked with meat, fish and vegetables by the *Nyishing*. It is sold in almost all the local markets of Arunachal Pradesh by women. *Lactobacillus plantarum*, *L. brevis*, *L. casei*, *Tetragenococcus halophilus* have been found in the samples<sup>6</sup>.

### Eup

*Eup* is also an ethnic fermented bamboo tender shoot product commonly prepared and consumed by *Nyishing* of Arunachal Pradesh. Edible bamboo shoots (*Dendrocalamus hamiltonii* Nees. et Arn. ex Munro, *Bambusa balcooa* Roxb., *Dendrocalamus giganteus* Munro, *Phyllostachys assamica* Gamble ex Brandis, *Bambusa tulda* Roxb.) are collected, outer casings are peeled off and washed. Bamboo shoots are chopped into small pieces and fermented in similar manner as in *ekung*. Fermentation is completed within 1-3 months (Fig. 10). Unlike *ekung*, *eup* is a dry product. *Eup* is again cut into smaller pieces and then drying in the sun for 5-10 days until its colour changes from whitish to chocolate brown. It is kept up to 2 yrs at ambient temperature. The dominant

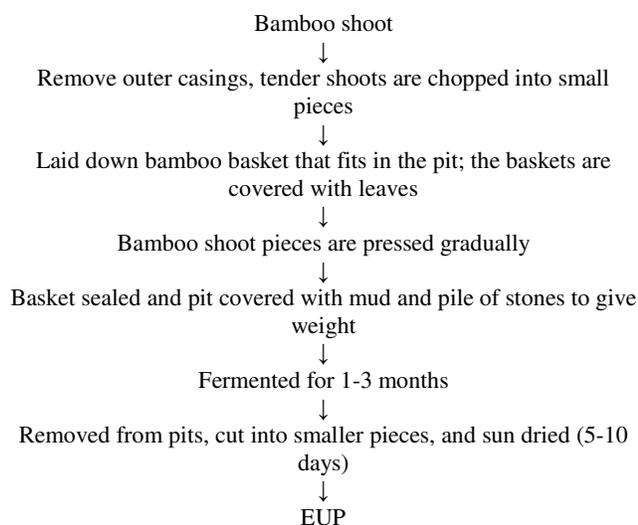


Fig. 10—Method of preparation of *eup* in Arunachal Pradesh

producer is the *Nyishing* women, supported by men. *Eup* is consumed as a curry along with meat, fish or vegetables. Curry of *eup* with meat is considered highly delicious by the people of Arunachal Pradesh. *Eup* is sold in the local markets by women. *Lactobacillus plantarum* and *L. fermentum* have been found in the samples<sup>16</sup>.

### Hirring

*Hirring* is an ethnic fermented topmost whole bamboo shoot product, commonly prepared in Arunachal Pradesh. Outer leaf sheaths of young bamboo shoots (*Dendrocalamus giganteus* Munro, *Phyllostachys assamica* Gamble ex Brandis, *Bambusa tulda* Roxb.) are removed. The topmost tender edible portions of the shoot are either cut longitudinally into 2-3 pieces of size 4-5 cm × 23-38 cm or whole shoots are flattened by crushing, and are put into bamboo baskets lined with leaves. The baskets are placed into the pit, covered with leaves, sealed and weighted down with heavy stones, and fermented for 1-3 months. After 1-3 months, baskets are taken out from pits, *hirring* is ready for consumption which is sour and has acidic taste (Fig. 11). It can be kept for 2-3 months at ambient temperature. The dominant producer is the *Apatani* women, supported by men. *Hirring* is consumed as curry often mixed with vegetables, meat and fish. Women sell the product in local markets. *Lactobacillus plantarum* and *Lactococcus lactis* have been found in the samples<sup>16</sup>.

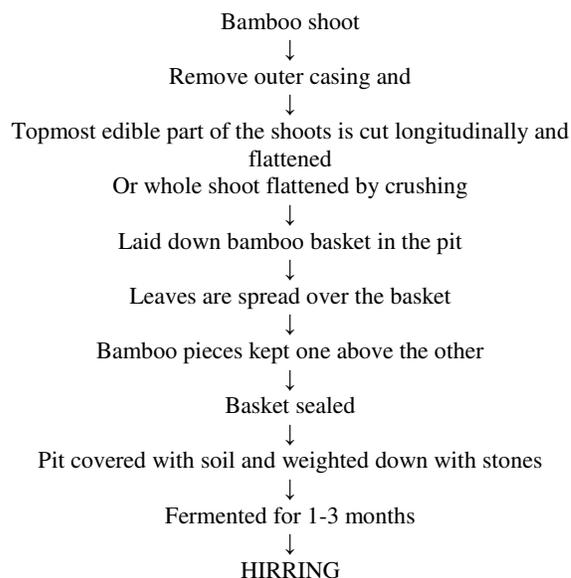


Fig. 11—Method of preparation of *hirring* in Arunachal Pradesh

### Lung-Siej

*Lung-siej* is an ethnic fermented bamboo shoot food of Meghalaya. It is prepared from *Dendrocalamus hamiltonii* species of bamboo grown in Meghalaya hills. Young bamboo shoots are selected, bract sheaths are removed, washed thoroughly with water, cleaned and shoots are sliced into small pieces and pressed into either bamboo cylinder or inside the glass bottle<sup>17</sup>. Bamboo cylinders are made by cutting the bamboo nodes in such a way that one side is closed while the other side remains open. Pieces of sliced bamboo shoots are filled inside the bamboo cylinder and is closed with the help of leaves and sealed by tying up the rim with thread or grass. The ends are sealed to prevent any accidental seepage of water into the cylinder which would turn the shoots black making the final product unfit for consumption. The bamboo cylinders are then immersed in the nearby stream upside down for a period of about 1-2 months for fermentation (Fig. 12).

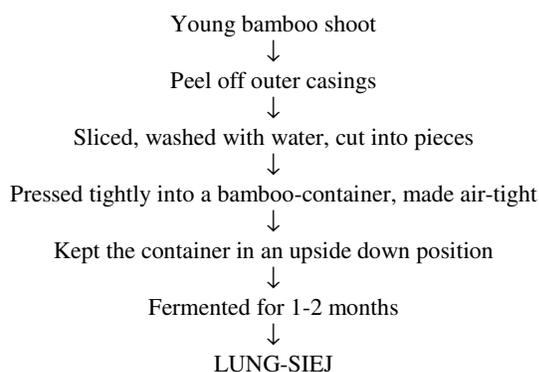


Fig. 12—*Lung-siej* preparation in Meghalaya

Use of glass bottle as fermenting container is also common now-a-days. In this process, the sliced shoots are pressed inside the glass bottle and then water is added till they are submerged. Then the bottle is closed tightly with the cap and kept above the kitchen oven for 1 month. The keeping quality of fermented bamboo shoots inside the bottle is better than the fermentation inside the bamboo cylinders. Shelf-life of *lungseij* prepared in glass-bottle is 10-12 months whereas *lungseij* prepared in bamboo cylinders should be consumed within 1 or 2 months. Fermentation of the bamboo shoots in glass bottles is more popular among the people of urban areas, whereas fermentation of bamboo shoots inside the bamboo cylinder is preferred by rural people<sup>17</sup>. The dominant producer is the *Khasi* women. *Lung-siej* is eaten curry mixed with meats and fish. It is sold in the

local market in Meghalaya by women. Lactic acid bacteria has been found in the samples.

### Anishi

*Anishi* is an ethnic fermented vegetable product prepared from leaves of yam and is used as condiment by *Ao* of Nagaland. Fresh mature green leaves of edible yam (*Colocasia* sp) are collected, washed, piled up and wrapped with banana leaves, and then kept aside for about 6-7 days till the leaves turn yellow. The yellow leaves are mixed with chili, salt and ginger, and then ground into paste. Finally paste is made into cakes which are kept above the earthen oven in the kitchen and fermented for 2-3 days (Fig. 13). The dried cakes *anishi* are ready for use as condiment<sup>18</sup>. The dominant producer is the *Ao* women and men. *Anishi* is used as condiment and is cooked with dry meat especially with pork, which is the favorite dish of the *Ao*. Microorganisms are not known in the samples.

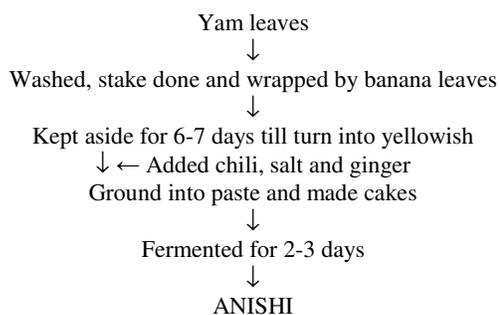


Fig. 13—*Anishi* preparation in Nagaland

### Conclusion

Information on the ethnic fermented vegetable and bamboo shoot products of Northeast India is sparse outside the region. The dominant functional microorganisms are the species of lactic acid bacteria exerting the bio-preservation of perishable vegetables and bamboo shoots by lowering pH and increasing acidity of the product<sup>8,13</sup>. Indigenous knowledge of the ethnic people of Northeast India on production of ethnic fermented vegetable products including fermented bamboo shoots is worth documenting, both as low-cost functional foods, and for socio-cultural reasons. Invention of biopreservation methods by the ethnic Northeast Indian women through pit fermentation or lactic acid fermentation is significant due to transforming of the availability of raw materials at a particular season to those of deficit.

Moreover, there is a remarkable step to store the perishable vegetable in absence of cold-storage or refrigeration, where majority of rural people cannot afford canned or frozen foods.

Sun drying of freshly prepared *gundruk*, *sinki* and *inziangsang* is a traditional preserving method by which the shelf life of the products is prolonged. Dried products are preserved for several months without refrigeration and consumed during long monsoon season when fresh vegetables are scarce. Dry *gundruk*, *sinki* and *inziangsang* are comparatively lighter than the weight of fresh substrates and can therefore, be carried easily while traveling. Because of the acidic taste, *gundruk*, *sinki* and *inziangsang* are said to be good appetizers, and the ethnic people use these foods for remedies from indigestion. These ethnic fermented foods have important bearing in the food culture of the people of Northeast India. Young succulent bamboo shoots are mostly used as an edible delicacy by different ethnic people of Northeast India. It is worth to notice that no preservative is added during storage in all above-mentioned fermented vegetable foods. The native skill of Northeast Indian women on use of indigenous LAB for biopreservation of perishable vegetables can be extended to preserve vast quantities of perishable leafy vegetables, cabbage, radish and yams in other parts of the country where such traditional vegetable fermentation technique is unknown.

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