Fermented products of India and its implication: A review

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ABSTRACT

The diversity of Indian fermented food and its significance as a potential source of lactic acid bacteria (LAB). Fermented foods in India are categorized based upon their base material. Fermented foods such as Dahi, Idli, Dosa, Gundruk, Sinki etc. As India’s population increases, lactic acid fermentation is expected to become an important role in preserving fresh vegetables, fruits, and other food items for feeding people. Among the food items, milk, fruits and vegetables are easily perishable due to their high water activity and nutritive values. These are more critical in our country which favors the growth of spoilage causing microorganisms. Lactic acid fermentation increases shelf life of fruits and vegetables and also enhances several beneficial properties, including an increase in nutritive value and flavors, reducing cooking time, and reduces toxicity. As a whole, the traditional fermented milk, fruits and vegetables not only serve as food supplements but also attribute towards health benefits. The objective of this review is to describe important fermented products of India and their significance.

Key words: Fermented foods, Lactic acid bacteria, Starter culture.

India, being a huge country has been the home of innumerable religious order of human population and diversity in climatic conditions has resulted in a large number of fermented foods. Most of these remain majorly secretive in their preparation being passed on from generation to generation and tend to be regionalized with many of them being made only on the home scale by using back slopping. Fermented foods have heterogeneity of traditions and cultural preferences found in the different geographical areas, where they are produced. They have been consumed since ancient times due to their prolonged shelf life, reduced volume, shorter cooking times and superior nutritive value as compared to the non-fermented ingredients. Fermentation processes are considered as developed in order to preserve food (Rolle and Satin, 2002). Fermentation is a slow decomposition reaction of organic substances accelerated by microorganisms or enzymes that essentially convert complex substances into simpler ones as carbohydrates to alcohols or organic acids (FAO, 1998). Fermented products are prepared by controlled fermentation to produce acidity and flavour to a desirable level. Fermentation enhances digestibility, flavor and aroma of food and exerts health promoting benefits through biological enrichment of food substrates with protein, essential amino acids, essential fatty acids, and vitamins. It may also assist in the destruction or detoxification of certain undesirable compounds which may be present in raw foods. There are different fermented products in India such as Idli, Dosa, Dhokla, Bhatura, Misti dahi, Kadhi, Gundruk, Sinki, etc. (Savitri and Bhalla, 2007). For preparation of fermented products starter culture is required. Starter culture is selected desirable microorganisms that are intentionally added to the base material to initiate and accomplish the desired fermentation in fermented products under controlled conditions. Lactic acid (LA) fermentation of foods as milk, vegetables and fruits is a common practice to preserve and improve the nutritional and sensory features of food (Karovicova and Kohajdova 2003; Demir et al., 2006; Cagno et al., 2013). Most of lactic acid bacteria (LAB) were isolated from various traditional naturally fermented foods and observed as lactic acid bacteria are the predominant microflora of fermented products (Anandharaj and Sivasankari, 2013). Indian traditional fermented foods are generally fermented by LAB such as Lactococcus spp. Lactobacillus plantarum, L. pentosus, L. brevis, L.
fermentum, L. casei, Leuconostoc mesenteroides L. kimchi, L. fallax, Weissella confusa, W. koreensis, W. cibaria, and Pediococcus pentosaceus etc. and they are considered as the probiotic source from these foods. Availability of certain specific nutrients such as vitamins, minerals and carbon source and also acidic nature of fruits and vegetables provides a growth medium for fermentation by LAB. Probiotics are the live microorganism which is administered in adequate amount it will give health benefits to the consumer (FAO, 2002), such as Lactobacillus plantarum, L. casei, L. acidophilus, and Streptococcus lactis, which are supplemented by food that beneficially affect the host by improving its intestinal balance (Tamang, 2009). Several studies have shown that supplementation of probiotics to food provides several health benefits such as reduction of serum cholesterol, improved gastrointestinal function, enhanced immune system, and lower risk of colon cancer (Berner and Donnell, 1998; McNaught and MacFie, 2001; Rafe 2003; Saarela et al., 2002). LAB are important for the dairy industry, especially in fermented milk processing because they increase food safety through the release of lactic acid and bacteriocins, produce aromas and flavor and accelerate the maturation process of cheese via their proteolytic and lipolytic activities, bring about desirable food textures via release of polysaccharides that increase the viscosity and firmness, and reduce susceptibility to syneresis. They may also be used to deliver polyunsaturated fatty acids and vitamins, leading to dairy products with increased nutritional value (Parvez et al., 2006).

FERMENTED FOODS
Fermented foods are foods that have been through a process of lactic fermentation in which natural bacteria feed on the sugar and starch in the food creating lactic acid. Fermentation preserves the food, and produce beneficial enzymes, B-vitamins, Omega-3 fatty acids, and various strains of probiotics. Natural fermentation of foods has also been shown to preserve nutrients in food and break the food down to a more digestible form.

Benefits of Fermented Food:
Preserves food: Fermentation increases the shelf life of food which preserve it by using lactic acid, alcohol and acetic acid

Adds microbes(good) to the gut: People get good bacteria to modulate the digestive system and proper digestion.

Increases micronutrients: Lactic acid bacteria can increase levels of vitamins in food, especially B vitamins.

Makes food more digestible: Food contains many anti-nutritive factors that not digested by people so these LAB useful to them. As the lactose in milk is broken down into simpler sugars – glucose and galactose, some people having problems of lactose intolerance they can easily consume fermented milk product. Also, many microbes produce enzymes that break down cellulose in plant foods, which humans can't digest, into sugars.

Changes in taste: It can make food pleasantly sour or tangy, and develops flavor.

Eliminates anti-nutrients: Anti-nutrients are the natural or synthetic compounds that interfere with the absorption of nutrients, which can be destroyed by fermentation. For example, Phytic acid, which is found in legumes and seeds, it binds minerals such as iron and zinc, reducing their absorption when eaten. However, phytic acid can be broken down during fermentation, so the minerals become available. Decreases cooking times: Foods that are tough, difficult to digest or unpalatable raw can be improved by fermentation, and reducing the need for cooking.

Produce carbon dioxide: Fermentive yeast and hetero-fermentative bacteria produce carbon dioxide. Carbon dioxide can be used for leavening bread and carbonating drinks.

CLASSIFICATION
Fermented foods are classified on basis of substrate used:
Fermented milk products
Fermented cereal- legume/ legume products
Fermented cereal products
Fermented vegetable and fruits products
Fermented meat and fish products
Miscellaneous foods

Following are the different fermented products available traditionally in Indian Subcontinent

Fermented milk products
Dahi: Traditionally, dahi is a naturally fermented milk product obtained from boiled cow or buffalo milk and soured using lactic cultures as Lactococcus lactis spp. lactis, Lactococcus lactis spp. cremoris, and L. diacetylactis it used separately or in combination. It is used in daily diet as a potential source of B-complex vitamins, folic acid, and riboflavin (Sharma and Lal, 1997, Sarkar et al., 2015). Dahi is rich in lactic acid bacteria and demonstrates the probiotic effect, which helps in intestinal health as helps in controlling diarrhea in children (Agarwal, 2002). Lactic acid bacteria produce bioactive compounds such as diacetyl, hydrogen peroxide, and reuterin suppress the normal growth of undesirable flora, especially E. coli, Bacillus subtilis, and Staphylococcus aureus (Sarkar and Misra, 2001; Sarkar et al., 2015).

Rabdi: Rabdi is a famous dairy product, prepared in the north-west part of India. It is a lactic acid-fermented milk product with pearl millet. Pearl millet has a lower glycemic index as compared to other cereals, which is helpful in managing noninsulin dependent diabetes mellitus, where primary cause is associated with an interruption in carbohydrate metabolism (Mani, 1993; Sarkar et al., 2015).
**Shrikhand/Shrikhandv ADI:** Shrikhand is sweetened dewatered dahi. It is very popular in western and some parts of southern India (Steinkraus, 1996). It is prepared mainly by cow milk or buffalo milk. It has a distinctive rich flavor and fairly long shelf life. To prepare shrikhand, dahi is suspended in a muslin cloth until all the free water has drained off. The semisolid mass in then whisked with sugar through a fine cloth, coloured and scented with saffron or rose-water, and flavoured with cardamom if desired (Mittal, 1977). To further extend the shelf life of shrikhand, a preparation known as shrikhandvadi, which is essentially a desiccated shrikhand, is made. The dewatered dahi is mixed with an equal amount of sugar by weight and dried in an open pan at low heat. When the mass begins to harden, it is tested for stickiness. The non-sticky product is flavoured and coloured. Powdered sugar is further added as desired. The product is mixed, rolled, cut into shapes, and packed like biscuits. The product yield is about 50% of the original weight of milk (Boghra and Mathur, 2000).

**Lassi:** Lassi is a traditional fermented milk beverage consumed in summer season for refreshment and is prepared from dahi. It is prepared by blending dahi with water, sugar, salt, and spices such as cumin seeds and coriander leaves. The presence of spices decreases thirst. Lassi is a probiotic product due to the presence of *L. acidophilus* and *S. thermophilus* as active cultures (Patidar and Prajapati, 1998; Sarkar et al., 2015). Based on the use of ingredients in Lassi, it is classified as salty Lassi or sweet Lassi. Bhang lassi is a special type of lassi prepared using the extract of cannabis plant leaves. It is prepared, especially on the occasion of Holi and Shivaratri festival. Bhang Lassi shows health benefits due to the presence of cannabis plant extracts, which help in relieving digestive problems, skin-related problems, fever, and sunstroke (Backes, 2014).

**Buttermilk:** Buttermilk is the liquid that is left over when butter is churned out of cream or dahi, consumed with or without added salt and spices. It has less fat content and fewer calories compared with regular milk or dahi. Buttermilk is as rich a source of calcium and protein as like milk. In some states of India, it is also known as Chaach. It is easier to digest and, with the presence of live cultures, helps in intestinal health. Buttermilk is consumed with meals and is advised in the Ayurveda (Pushpangadan et al., 2012).

**Milk cereal based fermented food**

**Kadi, churpa/churpi and nudu:** In Himachal Pradesh, traditional milk based products are prepared from the milk of several species of indigenous cattle, buffalo, sheep, goats, and Churu (hybrid of cow and yak) (Savitri and Bhalia, 2007). Kadi is prepared by simmering a mixture of chaach/buttermilk, besan/gramflour and spices (Sharma and Singh, 2012). Buttermilk is boiled, then water is discarded and solids are dried hard which later used to prepare soups called churpa or churpe and the predominant microflora is *Lactobacillus plantarum*, *L. curvatus*, *L. fermentum*, *L. paracasei* subsp. *pseudoplanterum* and *Leuconostoc mesenteroides* (Tamang et al., 2005; Tamang et al., 2009). Nudu is a ceremonial food prepared by cooking wheat flour in milk with a small amount of salt and is eaten with ghee (Savitri and Bhalia, 2007).

**Fermented cereal-legume/legume products**

**Idli:** It is a fermented product prepared from milled rice and dehulled black gram batter by steam cooking (Agarwal and Bhasin, 2002). Idli is a white colored, small, round, and spongy product. Rice and pulses are necessary for the preparation and also mixed natural microflora needed for efficient (Achaya, 1994). Black gram (*Phaseolus mungo* L.) is the primary ingredient having natural fermentation microflora and acts as the substrate for the fermentation of batter. Sour buttermilk is also used as a source of starter (Radakrishnamurty, 1961). Dehulled black gram and milled rice are used in the ratio of 1:2 for batter preparation. Fermentation of idli batter improves the nutrition and protein efficiency value (Reddy et al., 1982). Leavening is the main objective of fermentation in idli preparation. The major microorganisms involved in the leavening process are heterofermentative lactic acid bacterium, *Lactobacillus mesenteroides* and homofermentative lactic acid bacteria *Streptococcus faecalis* regulate the acidity of batter (Mukherjee et al., 1965). Additionally to these, probiotic microorganisms such as *Lactobacillus plantarum* and *Lactobacillus lactis* are also present in idli batter. These produce vitamin B12 and β-galactosidase enzyme, which promotes health (Iyer et al., 2013). Idli is used as a breakfast food in all seasons. Due to the fermentation process, idli is more digestible.

**Dosa:** Dosa is a fermented dish like idli, but the batter is thinner mainly found in the south Indian region (Steinkraus, 1996). It contains milled rice and dehulled black gram as primary ingredients. To improve the nutritional quality of dosa, finger millet and horse gram can be used as primary ingredients (Palanisamy et al., 2012). During fermentation, the volume of the batter doubles and as increase in fermentation time increases, the increase in protein content of batter (Soni et al., 1985). After fermentation, the leavened dosa batter is baked on hot pan as a thin, crisp pancake and consumed with ghee (Savitri and Bhalia, 2007). The Batter is in form of suspension, it is prepared by grinding wet rice and black gram separately with water. The two suspensions are then mixed and allowed to undergo natural fermentation, usually for 8–20 h. For preparation of dosa, the fermented suspension is spread in a thin layer (of 1–5 mm thickness) on a flat heated plate, which is smeared with a little oil and give heating to it, within a few minutes, a circular, semi-soft to crisp product resembling a pancake, ready for consumption (Battacharya and Bhat, 1997).

**Ambali:** It is a finger millet-based fermented semi-liquid product of south India. It prepared by mixing of finger millet
flour with water to make thick batter and followed by cooking and fermentation. The fermentation process decreases the leucine to lysine ratio (from 3.6 to 4.1) and increases in concentration of thiamine (Vit B₁), riboflavin (Vit B₂), and tryptophan and bioavailability of minerals. Leucine to lysine is an indicator of pellagragenic character of a protein (Deosthale et al., 1970; Aliya and Geervani, 1981; Sripryia et al., 1997 and Mbithi-Mwikya et al., 2000; Sarkar et al., 2015). The dominant microorganisms responsible for the fermentation of finger millet are Leuconostoc mesenteroides, Lactobacillus fermentum and Streptococcus faecalis (Ramakrishnan, 1980). Ambali contain high amount of calcium and low resistance starch because it prepared from finger millet (Mangala et al., 1999).

**Dhokla:** Dhokla is indigenous fermented food found mainly in Gujarat and Maharashtra state. It is prepared by fermentation of Bengal gram and rice. The method of preparation is the same as idli, but it is steamed openly rather than covered as is done in idli preparation (Steinkraus, 1995). During fermentation, lactic acid bacteria contribute to sour taste due to increase in the acidity of the product and improve the flavor. Starter culture used as yeast, since it produces folic acid and helps in making sponginess in food by increasing the batter volume (Kanekar and Joshi, 1993). The antioxidant property of fermented batter is high. Intake of free fatty acid and hyperglycemia condition in diabetic patient causes an increase in oxidative stress (Evans et al., 2002). The antioxidant property of Dhokla helps in curing age related diseases and oxidative stress-induced degenerative diseases (Moktan et al., 2011). So, dhokla can be a good food item in diet of diabetic patients and also others.

**Cereal and pulse based fermented food**

**Bhatooru, marchu and chilra:** These are leavened breads or roties constituting the staple diet of rural people in Himachal Pradesh (Savitri and Bhalia, 2007). Bhatooru, marchu and chilra are prepared by using wheat/barley/buckwheat flour as substrate and inoculum ‘Malera’ and ‘Treh’ respectively which is rich in lactic acid bacteria as Lactobacillus plantarum, L. acidophilus, Leuconostoc, Bacillus spp., Lactococcus lactis, Saccharomyces cerevisiae, Debaryomyces Hansenii, and Lactococcus lactis (Kanwar et al., 2007). Incubate a time period for fermentation to leaven the dough/slurry. The fermented dough of bhatooru and chilra and baked on hot plates while marchu is deep fried in mustard oil. Bhatouro is a staple diet of rural people and is taken in both meals with vegetables and curries. Marchu is prepared during festivals, religious and marriage ceremonies and is served with tea. Chilra is a favourite snack of the tribe served with coriander chutney, potato and mutton soup (Thakur et al, 2004).

**Kinema:** It is a soybean based fermented food (Deka, 2012) and consumed in eastern Himalayan regions of Darjeeling hills and Sikkim. It is a good and cheap source of protein (Tamang and Niiikuni, 1998). It is alkaline fermented, ammonia flavored food prepared from soybeans. For preparation soybean seeds are soaked overnight and then cracked slightly in a mortar and pestle. Grits are placed in a bamboo basket lined with locally grown fresh fern fronds covered with a jute bag and left to ferment naturally at ambient temperatures (25°-40°C) for 2-3 days above an earthen kitchen oven (Tamang, 2001). The microflora of Kinema is Bacillus subtilis, Enterococcus faecium, Candida parapsilosis and Geotrichum candidum (Sarkar et al, 1994). The product of fermented soybean is salted, deep fat fried and consumed as soup along with rice and vegetables (Sarkar et al, 1993). It contains protein 48 gm, fat 17 gm, carbohydrates 28 gm and 478 kilocalories per 100 gm of dry matter (Tamang, 2001).

**Tungrybai:** It is a traditional fermented food product prepared from soybean seeds used in Meghalaya. For preparation of it the soybean seeds are cleaned, washed and soaked in double quantity of water for about 4-6hours, outer skin is removed and then cooked in the same water till all water is absorbed. The cooked beans, which can now be pressed easily in a bamboo basket, lined on its inner surface with leaves of Clinogyne dichotoma (locally known as lamet) and allowed to cool and then left to ferment either in the ambient temperature (25–400 °C) or near the fire place in order to provide the essential temperature for fermentation to take place. The incubation time is usually 3-4 days and the fermented product is obtained as a brown mass with a characteristic odor (Sohliya et al, 2009; Jeyaram et al, 2009; Agrahar-Murukkar and Subbulakshmi, 2006). The microflora of Tungrybai is Bacillus subtilis and Enterococcus faecium, Candida parapsilosis, Saccharomyces bayanus, Saccharomyces fibuligera and Geotrichum candidum (Sohliya et al, 2009; Sarkar et al, 1993). It is a popular fermented soybean based sticky food which serves as a cheap source of high protein food in local diet (Sohliya et al, 2009).

**Hawaijar:** It is an alkaline-fermented soybean product consumed daily as a source of protein in Manipur. It consists of soluble proteins ranging from 26% to 27% (Thingom and Chhetry, 2011). It is non-salted and has a characteristic flavor and stickiness (Premarani and Chhetry, 2010). The microorganism mainly involved in the fermentation of this product is Bacillus spp. (Jeyaram, 2008). For preparation of hawaijar, bamboo baskets, banana leaves, or healthy fig leaves are used, which helps in fermentation and results in better quality of product. Presence of Bacillus spp. gives high fibrinolytic activity to the product (Singh et al., 2014). Since hawaijar is rich in proteins, it is recommended for adults and children older than 10 years.

**Jalebi:** It is a sweetened fermented product prepared by use of maida (refined wheat flour), dahi and water. The fermented batter is deep fat fried in oil in spiral shapes and immersed...
in sugar syrup for a few minutes. This traditional food is prepared during marriage ceremonies and festivals. *Lactobacillus fermentum, L. buchneri, Streptococcus lactis, S. faecalis* and *Saccharomyces cerevisiae* are found in the fermented batter. The pH decreases from 4.4 to 3.3 and there is a 9% volume increase in the batter. During fermentation both amino nitrogen and free sugar decreases (Steinkraus, 1996).

**Kulcha nan and Bhatura:** Various types of traditional fermented snack foods like Bhatura (white wheat flour product), Kulcha (white wheat flour product), Nan (wheat flour product), are prepared indigenously in India. For the fermentation of these products, mainly by *Saccharomyces cerevisiae* and LAB are used (Sanjeev and Sandhu, 1990).

**Kurdi and taotjo:** Kurdi is a type of wheat based solid fried chips, whereas taotjo is a kind of condiment made from fermentation of roasted wheat meal by *Aspergillus oryzae*, it is mainly popular in eastern India (Adams, 1998, Chavan and Kadam, 1989, Harlander, 1992, Sankaran, 1998, Soni and Sandhu, 1990, Blandinob et al., 2003).

**Fermented cereal products**

**Selroti:** It is a rice-based fermented food, which is spongy and ring shaped. It is consumed in Sikkim and Darjeeling. A local variety of rice is used for its preparation. Rice or rice flour is soaked overnight in cold water and then water is decanted. Soaked rice is pounded into small powder using wooden mortar and pestle. Then the rice is mixed with wheat flour, sugar, butter, and condiments such as cloves, cardamom, coconut, nutmeg and cinnamon. Milk or water is used for kneading the powder into soft dough for easy flow. The batter is incubating to ferment at ambient temperature for 2-4 hours, followed by molding into a ring and fried. It has served as a confectionery product (Yonzan and Tamang, 2009). The nutritive value of selroti is similar to idli and has a good amount of digestible proteins. *Lactobacilli, Pediococci, Enterococci, and Leuconostocs* are the principal microorganisms present in selroti (Yonzan and Tamang, 2010).

**Khaman:** It is similar to dhokla, but made wholly of Bengal gram dhal. Idli, Dhokla and Khaman are steamed unto the batter is leavened and acidified. The acid content inhibits the growth of food poisoning and food spoilage organisms (Sekar & Mariappan, 2007).

**Sez:** It is traditional semi-fermented food of Uttaranchal. It is made from rice, and mostly used as snacks. Earlier, it was prepared only during certain festivals. In most cases, sez is extracted while preparation of rice jann (local beer) (Roy et al, 2004).

**Adai and vada:** Both these are cereal legume based breakfast or snack food in India. Microorganisms required for the fermentation of both the products predominantly are *Pediococcus, Streptococcus, Leuconostoc* (Adams, 1998; Chavan & Kadam, 1989; Harlander, 1992; Sankaran, 1998; Soni & Sandhu, 1990 and Blandinob et al. 2003).

**Bhattejaanr and anarshe:** These both are rice based breakfast in India. Anarshe is sweetened snack food fermented by lactic acid bacteria, whereas bhattejaanr is sweet and sour alcoholic paste fermented by *Hansenula anomala* and *Mucor rouxianus* (Adams, 1998; Chavan & Kadam, 1989; Harlander, 1992; Sankaran, 1998; Soni & Sandhu, 1990; Blandinob et al., 2003).

**Fermented vegetable and fruits products**

**Gundruk:** Gundruk is a fermented food prepared from leaves of rayo-saag, mustard, or cauliflower. Leaves are wilted and shredded, crushed mildly and kept for natural fermentation in earthened jars/container, made air tight for about 7-10 days and sun dried for 3-4 days after completion of fermentation (Tamang and Tamang, 2009). The predominant microorganisms found as Lactic acid bacteria comprising *Lactobacillus, Leuconostoc, and Pediococcus*. *Lactobacillus fermentum, L. plantarum, L. casei, Pseudoplantarum and Pediococcus pentosaceus* (Tamang et al, 2005b). Gundruk soup is also a good appetizer (Tamang et al., 2005). Gundruk has a good amount of ascorbic acid, carotene, and lactic acid, and acts as an anticarcinogen (Tamang, 2010). It is consumed as soup or pickle (Tamang et al., 2012) It has high concentrations of calcium and magnesium (Moser et al., 1998).

**Vegetable based fermented food**

**Sinki:** It is a non-salted fermented radish tap root of the Gorkha (Tamang, 2005) and Gurung tribe of Sikkim prepared by fermentation in a 1m deep pit which is plastered with mud and warmed by burning (Tamang, 2005; Singh, 2007; Tamang and Tamang, 2009b). It prepared by washing of radish, cut into small pieces and dried under sunlight in naaglo (local utensil made of bamboo for winnowing the grains) for 3-4 days. Dried pieces are packed in polythene and placed inside a pit. The pit is covered with cow dung and soil paste and left for over 15 days for fermentation (Singh, 2007). Microorganisms observed as *Lactobacillus fermentum, L. brevis* and *L. plantarum* (Tamang, 1993). It has an acidic flavor, mostly used soup and pickle (Tamang and Tamang, 2009b). It contains 14.5% of protein, 2.5% of fat and 11.3% of ash of dry weight. It is an effective appetizer, cures diarrhea, stomach pain and consumed mostly during the lean period (Singh, 2007; Tamang and Tamang, 2009b).

**Anishi:** It is prepared from edible Colocasia species leaf (Deka, 2012). The fresh mature green leaves are washed, staked one above the other and wrapped in banana leaf. It is then kept for about a week till the leaves turn yellow and then ground into paste and cakes are made out. The cakes are dried over the fireplace in the kitchen. During grinding, chilly, salt and ginger are added to it. It is cooked with dry meat, especially with pork. It is liquid in nature, sour in taste and used as a condiment (Tamang and Tamang, 2009b).
Fermented meat and fish products

**Ngari:** The fermented fish product ngari forms an intrinsic part of the diet of people in Manipur (Deka, 2012). Phoubu, a sun dried, non-salted dry form of a fish species *Punctius sopordreis* used for the preparation of ngari dish (Jeyaram et al., 2009). It is prepared by sun dried and washed briefly with water and then water is drained for 24 hours. It is then spread, covered with gunny bags and pressed hard with legs followed by packing in an earthen pot of 45-50 kg capacity strengthened with metal lining (internally coated with mustard oil) and sealed tightly with mud. It is a 4 months to 12 months long process in which solid state fermentation takes place at room temperature and the microflora predominately occurred as *Lactococcus plantarum*, *Lactobacillus plantarum*, *Bacillus subtilis*, *B.pumilus*, *Miroccocus sp.* and *Enterococcus faecium* (Thapa et al., 2004; Nehal, 2013). It is eaten as a side dish with cooked rice. It is a rich source of proteins.

**Hentak:** Hentak is a ball-like thick a paste prepared by fermentation of a mixture of sun-dried fish (*Esomusdanricus*) powder and petioles of aroid plants (*Alocasimacrorhiza*) in Manipur. The mixture is kept in an earthen pot and is fermented for 7-9 days. It becomes to be eaten only after 2 weeks of complete fermentation giving proper texture and aroma to the dish. The microflora of Hentak is as *Bacillus cereus*, *B. subtilis*, *Staphylococcus aureus*, *Enterococcus faecium*, *Candida sp.* (Thapa et al., 2004). However, on being stored for a few months the balls harden which can then be used as a reserve food by its propounding it to a paste with a little water and stored as balls (Thapa et al., 2004; Thapa, 2002; Jeyaram et al., 2009). Hentak is consumed as curry as well as a condiment with boiled rice (Thapa, 2002). Sometimes it is given to women in the final stages of their pregnancy and patients recovering from sickness or injury (Sarojinalini and Singh, 1988; Sarkar et al., 2015).

**Miscellaneous food**

**Bamboo based fermented food:**

**Mesu:** It is bamboo shoot derived fermented food prepared by people of Himalayan regions of Darjeeling hills and Sikkim (Nehal, 2013). The months of June to September are suitable for the preparation of mesu when Bamboo shoots sprout. Locally available species of bamboo are used such as choya bans (*Dendrocalamus hamiltonii Nees and Arnott*), bhalu bans (*D. sikkimensis Gamble*) and karati bans (*BambusatuldaRoxb.*) (Tamang and Sarkar, 1996) which are defoliated, chopped and pressed tightly into a green bamboo hollow stem, the tip of stem is covered tightly with leaves and left to ferment for 7-15 days. The microflora of Mesu is mainly *Lactobacillus plantarum*, *L. brevis* and *L.pentosacoeus*. Mesu is mostly consumed as pickle (Sekar and Mariappan, 2007; Tamang and Sarkar, 1996; Tamang and Tamang, 2009a; Tamang and Tamang, 2009b).

**Soibum:** It is a fermented bamboo shoot product, an indigenous food of the state of Manipur used as a part of the diet. Soibum is produced exclusively from succulent bamboo shoots of the species *Dendrocalamus hamiltonii*, *D. sikkimensis*, *D.giganteus*, *Melocana bambusoide*, *Bambusa tulda* and *B. balcona* (Deka, 2012). Noney/ kwatha type and andro type are two types of fermentation procedures adopted. The outer inedible and hard casings of succulent bamboo sprouts are peeled off while and the soft portions are chopped and pressed tightly into wooden or earthen pots and left to ferment for 6-12 months in both the methods (Jeyaram et al., 2009). The microflora of Soibum is *Enterococcus durans*, *Streptococcus lactis*, *B. subtilis*, *L. licheniformis*, *B. coagulans*, *Candida spp.*, *Saccharomyces spp.*, *Torulopsis spp*. It is consumed as regular side dish consumed with steamed rice. The bamboo shoots are rich in potassium, carbohydrates, dietary fibers, vitamins and various antioxidants (Tamang and Tamang, 2009b).

**CONCLUSION**

The large diversity in traditional fermented foods of India because the regional health foods has evolved according to the climate, culture, and cropping practices of a particular region. These fermented products having various benefits as processing, production and health. Moreover, certain foods have become more popular in certain regions according to the health condition of a population, such as lactose intolerance leads to popularization of lactose-free dairy sweets. Some traditional fermented foods are not explored geographically, hence the study of these fermented products required and formulates the product with defined micro-flora then it maintains the characteristics and quality of food.

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