Review: Diversty of Microorganisms in Global Fermented Foods and Beverages

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Abstract

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Ethics statement

(Authors are required to state the ethical considerations of their study in the manuscript including for cases where the study was exempt from ethical approval procedures.)

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Review: Diversty of Microorganisms in Global Fermented Foods and Beverages

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Abstract

Majority of global fermented foods is naturally fermented by both cultivable and uncultivable microorganisms. Food fermentations represent an extremely valuable cultural heritage in most regions, and harbour a huge genetic potential of valuable but hitherto undiscovered strains. Holistic approaches for identification and complete profiling of both culturalable and unculturable microorganisms in global fermented foods are interest to food microbiologists. The application of molecular and modern identification tools through culture-independent techniques has thrown new light on the diversity of a number of hitherto unknown and uncultivable microorganisms in naturally fermented foods. Functional bacterial groups ("phylotypes") may be reflected by their mRNA expression in a particular substrate and not by mere DNA-level detection. An attempt is made here to review the microbiology of some global fermented foods and alcoholic beverages.

Introduction

Traditionally, boiled rice is a staple diet with fermented and non-fermented legume (mostly soybeans) products, vegetables, pickles, fish and meat as side-dish in Far East Asia, South Asia, North Asia and the Indian subcontinent excluding Western and Northern India; wheat/barley-based breads/loaves comprise a staple diet followed by milk and fermented milk products, meat and fermented meats (sausages) in the Western and Northern part of India to West Asian continent, Europe, North America and even in Australia and New Zealand (Tamang and Samuel, 2010). Sorghum/maize porridges, on the other hand, are main courses of diets with many fermented and non-fermented sorghum/maize/millets, cassava, wild legume seeds, meat, and milk products in Africa and South America. Many food researchers have defined fermented foods by their own interpretation, e.g., Hesseltine (1965, 1979) who defined traditional fermented foods as those that have been used for centuries even predating written historical records and are essential for well-being of many people throughout the world. Steinkraus (1994, 1996, 2002) defined indigenous fermented foods as foods where microorganisms bring about some biochemical changes in the substrates during fermentation such as enrichment of human diet through development of a wide diversity of flavours, aromas and texture in foods, by preservation through lactic acid, alcoholic, acetic acid and alkaline fermentation, by biological enrichment of food substrates with protein, essential amino acids, essential fatty acids and vitamins, and also by detoxification of undesirable compounds and decrease in cooking times and fuel requirements. Campbell-Platt (1987,

1994) defined fermented foods as foods that have been subjected to the action of microorganisms or enzymes so that desirable biochemical changes cause significant modification to the food. Holzapfel (1997) described fermented foods as palatable and wholesome foods, prepared from raw or heated raw materials by microbial fermentation. Tamang (2010b) defined ethnic fermented foods as foods produced by the ethnic people (of specific culture and using their native knowledge) from locally available raw materials of plant or animal sources either naturally or by adding starter culture(s) containing functional microorganisms, which modify the substrates biochemically, and organoleptically into edible products that are culturally and socially acceptable to the consumers. Biochemically, fermentation is defined as the process, which does not require O2, but by using an organic molecule as electron acceptor and performed only by active living cells of microorganisms (Mansi et al., 2003).

Several researchers have reviewed the microbiology, biochemistry and nutrition of fermented foods and beverages of different countries of Asia (Heseltine, 1979, 1983; Kozaki, 1976; Lee, 1997; Nout and Aidoo, 2002; Soni and Dey, 2014; Steinkraus, 1996, 1997; Tamang, 2010a, 2012); Africa (Odunfa and Oyewole, 1997; Olasupo et al., 2010; Franz et al., 2014); Europe (Pederson, 1979; Wood, 1998); South America (Chavez-Lopez et al., 2014), and North America (Doyle and Beuchat, 2013; Fleming, 1984). Many genera/species of microorganisms have been reported for various fermented foods and beverages across the world; using molecular tools in recent years has helped to clarify, at least in part, the nomenclatural confusion and generalisations caused by conventional (phenotypic) taxonomic methods. The present paper is an attempt to collate and review the updated information on microbiology of some global fermented foods and beverages.

Microorganisms in fermented foods

Fermented foods are the hubs of consortia of microorganisms which may be present as natural indigenous microbiota in uncooked plant or animal substrates, utensils, containers, earthen pots, and the environment (Franz et al. 2014; Hesseltine and Wang, 1967; Steinkraus, 1996), or as a result of addition of the microorganisms as starter cultures (Stevens and Nabors, 2009). Microorganisms convert the chemical composition of raw materials during fermentation, which enrich the nutritional value in some fermented foods, and impart health-benefits to conusmers (Farhad et al., 2010; Steinkraus, 2002; Tamang, 2015a).

Lactic acid bacteria (LAB) are widely present in many fermented foods and beverages (Stiles and Holzapfel, 1997; Tamang, 2010b). Major genera of the LAB isolated from various global fermented foods and beverages *Alkalibacterium*, *Carnobacterium, Enterococcus*, *Lactobacillus*, *Lactococcus*, *Leuconostoc*, *Oenococcus*, *Pediococcus*, *Streptococcus*, *Tetragenococcus*, *Vagococcus* and *Weissella* (Axelsson et al., 2012; Holzapfel and Wood, 2014; Salminen et al., 2004).

Bacillus is present in alkaline-fermented foods of Asia and Africa (Parkouda et al., 2009; Tamang, 2015). Species of *Bacillus* present, mostly in legume-based fermented foods, are *B. amyloliquefaciens, B. circulans, B. coagulans, B. firmus*, *B. licheniformis, B. megaterium, B. pumilus, B. subtilis, B. subtilis* variety *natto,* and *B. thuringiensis* (Kiers et al., 2000; Kubo et al., 2011), while, in addition, strains of *B. cereus* have been isolated from the fermentation of *Prosopis africana* seeds for the production of *okpehe* in Nigeria (Oguntoyinbo et al., 2007). Some strains of *B. subtilis* produce λ-polyglutamic acid (PGA) which is an amino acid polymer commonly present in Asian fermented soybean foods giving the characteristic sticky texture to the product (Nishito et al., 2010; Urushibata et al., 2002).

The association of several species of *Kocuria, Micrococcus* (members of the *Actinobacteria*) and *Staphylococcus* (belonging to the *Firmicutes*) have been reported for fermented milk products, fermented sausages and meat and fish products (Coton et al., 2010; Martin et al., 2006). Species of *Bifidobacterium, Brachybacterium, Brevibacterium,* and *Propionibacterium* are isolated from cheese and species of *Arthrobacter* and *Hafnia* from fermented meat products (Bourdichon et al., 2012). *Enterobacter cloacae*, *Klebsiella pneumoniae, K. pneumoniae* subsp. *ozaenae, Haloanaerobium, Halobacterium, Halococcus*, *Propionibacterium, Pseudomonas,* and various others are also present in many global fermented foods (Tamang, 2010b).

Genera of yeasts reported for fermented foods, alcoholic beverages and non-food mixed amylolytic starters are *Brettanomyces*, *Candida, Cryptococcus, Debaryomyces, Dekkera*, *Galactomyces, Geotrichum, Hansenula, Hanseniaspora, Hyphopichia, Issatchenkia*, *Kazachstania*, *Kluyveromyces, Metschnikowia, Pichia, Rhodotorula, Rhodosporidium,* *Saccharomyces, Saccharomycodes, Saccharomycopsis, Schizosaccharomyces, Sporobolomyces, Torulaspora*, *Torulopsis, Trichosporon, Yarrowia* and *Zygosaccharomyces* (Kurtzman et al., 2011; Lv et al., 2013; Tamang and Fleet, 2009; Watanabe et al., 2008).

Major roles of filamentous moulds in fermented foods and alcoholic beverages are mainly production of enzymes and also degradation of anti-nutritive factors (Aidoo and Nout, 2010). Species of *Actinomucor, Amylomyces, Aspergillus, Monascus, Mucor, Neurospora, Parcilomyces, Penicillium, Rhizopus* and *Ustilago* are reported for many fermented foods, Asian non-food amylolytic starters and alcoholic beverages (Chen et al., 2014; Nout and Aidoo, 2002).

Taxonomic tools for identification of microorganisms from fermented foods

Use of culture media may ignore several unknown uncultivable microorganisms that may play major or minor functional roles in production of fermented foods. Direct DNA extraction from samples of fermented foods, commonly called culture-independent methods, is nowadays frequently used in food microbiology to profile both cultivable and uncultivable microbial populations from fermented foods (Cocolin and Ercolini, 2008; Alegría et al., 2011; Cocolin et al., 2013; Dolci et al. 2015), provided that the amplification efficiency is high enough. PCR-DGGE analysis is the most popular culture-independent technique used for detecting microorganisms in fermented foods and thereby profiling both bacterial populations (Cocolin et al., 2011; Tamang, 2014) and yeast populations in fermented foods (Cocolin et al., 2002; Jianzhonga et al., 2009). Both cultivable and uncultivable microorganisms from any fermented food and beverage may be identified using culture-dependent and -independent methods to document a complete profile of microorganisms, and also to study both inter- and intra-species diversity within a particular genus or among genera (Greppi et al. 2013a,b; Ramos et al., 2010; Yan et al., 2013). The method uses a combination of intercalating dye, propidium monoazide (PMA) which selectively penetrates dead cells through their compromised cell membranes, and both quantitative PCR (qPCR) (Fujimoto and Watanabe, 2013) and pyrosequencing (Desfossés-Foucault et al., 2012) have been developed. Combining PMA treatment of samples before DNA exraction and the molecular quantifying methods can be used to accurately enumerate the viable microorganisms in fermented foods.

Molecular identification is emerging as an accurate and reliable identification tool, and is widely used in identification of both culture-dependent and culture-independent microorganisms from fermented foods (Dolci et al., 2015; Giraffa and Carminati, 2008). Species-specific PCR primers are used for species level identification (Tamang et al., 2005); this technique is widely applied in the identification of LAB isolated from fermented foods (Robert et al., 2009). The application of real-time quantitative PCR (qPCR) with specific primers enables the specific detection and quantification of LAB species in fermented foods (Park et al., 2009).

Random amplification of polymorphic DNA (RAPD) is a typing method based on the genomic DNA fragment profiles amplified by PCR and is commonly used for discrimination of LAB strains from fermented foods (Chao et al., 2008; Coppola et al., 2006). The repetitive extragenic palindromic sequence-based PCR (rep-PCR) technique permits typing at subspecies level and reveals significant genotypic differences between strains of the same bacterial species from fermented foods samples (Tamang et al., 2008). Amplified fragment length polymorphism (AFLP) is a technique based on the selective amplification and separation of genomic restriction fragments, and its applicability in identification and to discriminate has been demonstrated for various LAB strains (Tanigawa and Watanabe, 2011).

Techniques of denaturing gradient gel electrophoresis (DGGE) and temperature gradient gel electrophoresis (TGGE) have been developed to profile microbial communities directly from fermented foods, and are based on sequence-specific distinctions of 16S rDNA or 26S rDNA amplicons produced by PCR (Alegría et al., 2011; Ercolini, 2004; Flórez and Mayo, 2006). However, use of DGGE has also some disadvantages such as being time consuming, unable to determine the relative abundance of dominant species, or to distinguish between viable and non-viable cells, and difficulties in interpretation of multi-bands (Dolci et al., 2015). DGGE can only reveal some of the major bacterial species such as *B. licheniformis* and *B. thermoamylovorans* in *chungkokjang* (sticky fermented soybean food of Korea) and could not detect a large number of predominant or diverse rare bacterial species identified in pyrosequencing analysis (Nam et al., 2011).

The amplified ribosomal DNA restriction analysis (ARDRA) technique using restriction enzymes is also useful in identification of microorganisms from fermented foods (Jeyaram et al., 2010).

Multilocus sequence analysis (MLSA), using housekeeping genes as molecular markers alternative to the 16S rRNA genes, is used for LAB species identification: *rpoA* and *pheS* genes for *Enterococcus* and *Lactobacillus*, *atpA* and *pepN* for *Lactococcus* species, and *dnaA*, *gyrB*, and *rpoC* for species of *Leuconostoc, Oenococcus*, and *Weissella* (de Bruyne et al., 2007, 2008b, 2010; Diancourt et al., 2009; Picozzi et al., 2010; Tanigawa and Watanabe, 2011).

Effective tools of next generation sequencing (NGS) such as metagenomics, phylobiomics, and metatranscriptomics are nowadays applied for documentation of cultures in traditional fermented products (Mozzi et al., 2013; van Hijum et al., 2013). However, NGS as a sophisticated tool needs well-trained hands and a well equipped molecular laboratory, which may not always be available. Application of metagenomic approaches by using parallel pyrosequencing of tagged 16S rRNA gene amplicons provide information on microbial communities as profiled in *kimchi*, a naturally fermented vegetable product of Korea (Jung et al., 2011; Park et al., 2012), *nukadoko*, a fermented rice bran of Japan (Sakamoto et al., 2011), *narezushi*, a fermented salted fish and cooked rice of Japan (Kiyohara et al., 2012), and *ben-saalga*, a traditional gruel of pearl millet of Burkina Faso (Humblot and Guyot, 2009). Pyrosequencing has revealed the presence of numerous and even minor bacterial groups in fermented foods, but DNA-level detection does not distinguish between metabolically active and "passive" organisms. "Functionally relevant phylotypes" in an ecosystem may be specifically detected by, e.g., weighted UniFrac principal coordinate analysis based on 454 pyrosequencing of 16S rRNA genes, as applied in studies on gut microbiota (Wang et al., 2015). The 16S rRNA gene sequence based pyrosequencing method enables a comprehensive and high-throughput analysis of microbial ecology (Sakamoto et al., 2011), and this method has been applied to various traditional fermented foods (Oki et al., 2014).

A proteomics identification method based on protein profiling using matrix-assisted laser desorption ionizing-time of flight mass spectrometry (MALDI-TOF MS) is used to identify species of *Bacillus* in fermented foods of Africa (Savadogo et al., 2011), and species of LAB isolated from global fermented foods (Dušková et al., 2012; Kuda et al., 2014; Nguyen et al., 2013a; Sato et al., 2012; Tanigawa et al., 2010).

Global fermented foods

Campbell-Platt (1987) reported around 3500 global fermented foods and beverages with some 250 groups. We presume that there may be more than 5000 varieties of common and uncommon fermented foods and alcoholic beverages being consumed in the world by billions of people as staple and other food components (Tamang, 2010b). Global fermented foods are classified into nine major groups on the basis of substrates (raw materials) used from plant/animal sources: (1) fermented cereals, (2) fermented vegetables and bamboo shoots, (3) fermented legumes, (4) fermented roots/tubers, (5) fermented milk products, (6) fermented and preserved meat products, (7) fermented, dried and smoked fish products, (8) miscellaneous fermented products, and (9) alcoholic beverages (Steinkraus, 1997; Tamang 2010b,c).

Fermented milk products

Fermented milks (Table 1) are classified into two major groups on the basis of dominant microorganisms: (A) lactic fermentation, dominated by species of LAB, comprising the "thermophilic" type (e.g., yogurt, Bulgarian buttermilk), probiotic type (e.g., acidophilus milk, bifidus milk), and the mesophilic type (e.g., natural fermented milk, cultured milk, cultured cream, cultured buttermilk); and (B) fungal-lactic fermentations, where LAB and yeasts cooperate to generate the final product. Typical examples include alcoholic milks (e.g., acidophilus-yeast milk, *kefir, koumiss*), and mouldy milks (e.g., *viili*) (Mayo et al., 2010). Yogurt is widely consumed highly nutritious fermented milk, and is defined by the Codex Alimentarius (Donovan and Shamir, 2014). Natural fermentation is one of the oldest methods of milk processing using raw or boiled milk to ferment spontaneously or by using the back-slopping method, where a part of a previous batch of a fermented product is used to inoculate the new batch (Holzapfel, 2002; Josephsen and Jespersen, 2004).

Fermented cereal foods

Cereal fermentation is mainly represented by species of LAB and yeasts (Corsetti and Settanni, 2007). *Enterococcus*, *Lactococcus*, *Lactobacillus*, *Leuconostoc*, *Pediococcus*, *Streptococcus* and *Weissella* are common bacteria associated with cereal fermentations (Table 2) (de Vuyst et al., 2009; Guyot, 2010; Moroni et al., 2011). Native strains of *Saccharomyces cerevisiae* are the principal yeast of most bread fermentations (Hammes et al., 2005), but other non-*Saccharomyces* yeasts are also significant in many cereal fermentations, including *Candida, Debaryomyces, Hansenula, Kazachstania, Pichia, Trichosporon* and *Yarrowia* (Iacumin et al., 2009; Johnson and Echavarri-Erasun, 2011; Weckx et al., 2010).

Fermented vegetable foods

Perishable and seasonal leafy vegetables, radish, cucumbers, including young edible bamboo tender shoots, are traditionally fermented into edible products of wide diversity, especially in Asia (Table 3). Fermentation of vegetables is mostly dominated by species of *Lactobacillus* and *Pediococcus*, followed by *Leuconostoc, Weissella, Tetragenococcus*, and *Lactococcus* (Chang et al., 2008; Watanabe et al., 2009a). A complete microbial profile of LAB in *kimchi* has been characterised using different molecular identification tools (Jung et al., 2011, 2013a; Nam et al., 2009; Park et al., 2010; Shin et al., 2008;). Natural fermentations during production of *sauerkraut*, a fermented cabbage product of Germany, have studied and species of LAB were reported (Johanningsmeier et al., 2007; Plengvidhya et al., 2007). Species of LAB constitute the native population in the Himalayan fermented vegetable products such as *gundruk, sinki, goyang, khalpi,* and *inziangsang* (Karki et al., 1983; Tamang and Tamang, 2007, 2010; Tamang et al., 2005; 2009) and several naturally fermented bamboo products of India and Nepal (Jayaram et al., 2010; Sonar and Halami, 2014; Tamang and Sarkar, 1996; Tamang and Tamang, 2009; Tamang et al., 2008).

Fermented soybeans and other legumes

Two types of fermented soybean foods are produced: soybean foods fermented by *Bacillus* spp. (mostly *B. subtilis*) with characteristic stickiness, and soybean foods fermented by filamentous moulds, mostly *Aspergillus, Mucor, Rhizopus* (Tamang, 2010b). *Bacillus*-fermented, non-salty and sticky soybean foods are concentrated in an imaginary triangle with three vertices on Japan (*natto*), east Nepal and North East India (*kinema* and its similar products) and northern Thailand (*thua-nao*) named as '*natto* triangle' (Nakao, 1972) and renamed as '*kinema-natto-thuanao* (KNT)-triangle' (Tamang, 2015b). Within the KNT-triangle-bound countries, *Bacillus*-fermented sticky non-salty soybean foods are consumed such as *natto* of Japan, *chungkokjang* of Korea, *kinema* of India, Nepal and Bhutan, *aakhune, bekang*, *hawaijar*, *peruyaan* and *tungrymbai* of India, *thua nao* of Thailand, *pepok* of Myanmar, and *sieng* of Cambodia and Laos (Nagai and Tamang, 2010; Tamang 2015 b) (Table 4). Although the method of production and culinary practices vary from product to product, plasmids and phylogenetic analysis of *B. subtilis* showed the similarity among strains of *B. subtilis* isolated from common sticky fermented soybean foods of Asia (Hara et al., 1986, 1995; Meerak et al., 2007; Tamang et al., 2002) suggesting origination from the same stock. Mould-fermented soybean products are *miso* and *shoyu* of Japan, *tempe* of Indonesia, *douchi* and *sufu* of China, *doenjang* of Korea (Sugawara, 2010). Some common non-soybean fermented legumes (e.g., locust beans) of Africa are *bikalga, dawadawa, iru, okpehe, soumbala* and *dugba* (Ahaotu et al., 2013; Amoa-Awua et al., 2006; Azokpota et al., 2006; Meerak et al., 2008; Oguntoyinbo et al., 2007, 2010; Ouoba et al., 2004, 2008, 2010; Parkouda et al., 2009), fermented black-grams products such as *dhokla, papad* and *wari* of India (Nagai and Tamang, 2010), and *maseura* of India and Nepal (Chettri and Tamang, 2008).

Species of *Bacillus* have been reported for several Asian fermented soybean foods Sarkar et al., 2002; Tamang et al., 2002; Park et al., 2005; Inatsu et al., 2006; Choi et al., 2007; Kimura and Itoh, 2007; Shon et al., 2007; Jeyaram et al., 2008b; Dajanta et al., 2009; Kwon et al., 2009; Kubo et al., 2011; Singh et al., 2014; Tamang, 2003; Wongputtisin et al., 2014; Chettri and Tamang, 2015). However, *B. subtilis* is the dominant functional bacterium in Asian fermented soybean foods (Sarkar and Tamang, 1994; Tamang and Nikkuni, 1996; Dajanta et al., 2011). Japanese *natto* is the only *Bacillus*-fermented soybean food now produced by commercial mono-culture starter *B. natto*, first isolated from naturally fermented *natt*o by Sawamura (Sawamura, 1906). *Ent. Faecium*, as minor population group, is also present in *kinema* (Sarkar et al., 1994), in *okpehe* (Oguntoyinbo et al., 2007), and in *chungkukjang* (Yoon et al., 2008).

Fermented root and tuber products

Cassava (*Manihot esculenta*) root is traditionally fermented into staple foods such as *gari* in Nigeria, *fufu* in Togo, Burkina Faso, Benin and Nigeria, *agbelima* in Ghana, *chikawgue* in Zaire*, kivunde* in Tanzania, *kocho* in Ethiopia, *foo foo* in Nigeria, Benin, Togo and Ghana, respectively (Franz et al., 2014) (Table 5). The initial stage of cassava fermentation is dominated by *Corynebacterium manihot* (Oyewole et al., 2004) with LAB succession (*Lb. acidophilus*, *Lb. casei, Lb. fermentum, Lb. pentosus, Lb. plantarum* (Oguntoyinbo and Dodd, 2010)**.** Cassava root is also traditionally fermented into sweet dessert known as *tapé* in Indonesia (Tamang, 2010b).

Fermented meat products

Information on microbiota of some traditionally preserved and fermented meat products of the world is summarised in Table 6. LAB predominate in most fermented meat products (Albano et al., 2009; Cocolin et al., 2011; Khanh et al., 2011; Nguyen et al., 2013b), followed by coagulase-negative staphylococci, micrococci and *Enterobacteriaceae* (Cocolin et al., 2011; Marty et al., 2011) and yeasts such as *Debaryomyces hansenii* (Encinas et al., 2000; Tamang and Fleet, 2009). Selection of non-toxinogenic moulds for meat ripening has resulted in the commercialisation of strains of *Penicillium nalgiovense* (Lücke, 2015).

Fermented fish products

Preservation of fish through fermentation, sun/smoke drying and salting (Table 7) is traditionally practiced by people living nearby coastal regions, lakes and rivers and is consumed as seasoning, condiments and side dish (Salampessy et al., 2010). Several species of bacteria and yeasts have been reported from fermented and preserved fish products of the world (Hwanhlem et al., 2011; Kobayashi et al., 2000a,b,c; Saithong et al., 2010; Thapa et al., 2004, 2006, 2007; Wu et al., 2000).

Miscellaneous fermented products

Vinegar is one of the most popular condiments in the world and is prepared from sugar or ethanol containing substrates and hydrolyzed starchy materials by aerobic conversion to acetic acid (Solieri and Giudici, 2008). *Acetobacter aceti* subsp. *aceti, A. oryzae, A. pasteurianus, A. polyxygenes, A. xylinum, A. malorum*, *A. Pomorum* dominate during vinegar production (Haruta et al., 2006), while yeast species such as *Candida lactis-condensi*, *C. stellata*, *Hanseniaspora valbyensis*, *H. osmophila*, *Saccharomycodes ludwigii, Sacch.cerevisiae, Zygosaccharomyces bailii*, *Z. bisporus, Z. lentus*, *Z. mellis*, *Z. Pseudorouxii* and *Z. Rouxii* have also been reported (Sengum and Karabiyikli, 2011).

Though normal black tea is consumed everywhere, some ethnic Asian communities enjoy special fermented teas such as *miang* of Thailand (Tanasupawat et al., 2007), *puer* tea and *fuzhuan brick*, and *kombucha* of China (Mo et al., 2008). *Aspergillus niger* is the predominant fungus in *puer* tea while *Blastobotrys adeninivorans, Asp. glaucus*, species of *Penicillium*, *Rhizopus* and *Saccharomyces* and the bacterial species *Actinoplanes* and *Streptomyces* were also isolated (Abe et al., 2008; Jeng et al., 2007). *Brettanomyces bruxellensis, Candida stellata*, *Rhodotorula mucilaginosa, Saccharomyces* spp.*, Schizosaccharomyces pombe, Torulaspora delbrueckii, Zygosaccharomyces bailii, Z. bisporus, Z. kombuchaensis* and *Z. microellipsoides* were isolated from *kombucha* (Kurtzuman et al., 2001; Teoh et al., 2004). Major bacterial genera present in *kombucha* were *Gluconacetobacter*. However, Marsh et al. (2014) reported the predomination of *Lactobacillus*, *Acetobacter,* and *Zygosaccharomyces*. *Lb. thailandensis, Lb. camelliae*, *Lb. plantarum, Lb. pentosus, Lb. vaccinostercus*, *Lb. pantheris, Lb. fermentum, Lb. suebicus, Ped. siamensis, Ent. casseliflavus* and *Ent. camelliae* are involved in the fermentation of *miang* production (Sukontasing et al., 2007; Tanasupawat et al*.,* 2007). Species of *Aspergillus, Penicillium* and *Eurotium* are major fungi for fermentation of *fuzhuan brick* tea (Mo et al., 2008).

Nata or bacterial cellulose produced by *Acetobacter xylinum* is a delicacy of the Philippines, eaten as candy (Adams, 2014; Chinte-Sanchez, 2008; Jagannath et al., 2010). Two types of *nata* are well known: *nata de piña,* produced on the juice from pineapple trimmings, and *nata de coco,* produced on coconut water or coconut skim milk (Adams, 2014). Bacterial cellulose has significant potential as a food ingredient in view of its high purity, *in situ* change of flavour and colour, and having the ability to form various shapes and textures (Shi et al., 2014).

Chocolate is a product of cocoa bean fermentation where *Lb. fermentum* and *Acetobacter pasteurianus* were reported as the predominating bacterial species (Lefeber et al., 2010; Papalezandratou et al., 2011)**.** Diverse LAB species appear to be typically associated with the fermentation of cocoa beans in Ghana, which included *Lb. ghanensis* (Nielsen et al., 2007), *Weissella ghanensis* (de Bruyne et al., 2008), *Lb. cacaonum* and *Lb. fabifermentans* (de Bruyne et al., 2009) and *Weissella fabaria* (de Bruyne et al., 2010). *Fructobacillus pseudoficulneus*, *Lb. plantarum*, *Acetobacter senegalensis* and the enterobacteria *Tatumella ptyseos* and *Tatumella citrea* were among the prevailing species during the initial phase of cocoa fermentations (Papalezandratou et al., 2011)**.** Yeasts involved during spontaneous cocoa fermentation are *Hanseniaspora uvarum, H. quilliermundii*, *Issatchenkia orientalis (Candida krusei*), *Pichia membranifaciens*, *Sacch. cerevisiae* and *Kluyveromyces* species for flavour development (Schillinger et al., 2010).

Pidan is a preserved egg prepared from alkali-treated fresh duck eggs is consumed by the Chinese, and has a strong hydrogen sulfide and ammonia smell (Ganasen and Bejakul, 2010). The main alkaline chemical reagent used for making *pidan* is sodium hydroxide, which is produced by the reaction of sodium carbonate, water, and calcium oxide of pickle or coating mud. *B. cereus, B. macerans, Staph. cohnii*, *Staph. epidermidis*, *Staph. haemolyticus* and *Staph. warneri* are predominant in *pidan* (Wang and Fung, 1996).

Alcoholic beverages

Tamang (2010c) classified alcoholic beverages of the world into 10 types:

1) Non-distilled and unfiltered alcoholic beverages produced by amylolytic starters e.g., *kodo ko jaanr* (fermented finger millets) (Thapa and Tamang, 2004), and *bhaati jaanr* (fermented rice) of India and Nepal (Tamang and Thapa, 2006), *makgeolli* (fermented rice) of Korea (Jung et al., 2012).
2) Non-distilled and filtered alcoholic beverages produced by amylolytic starters e.g., *saké* of Japan (Kotaka et al., 2008).
3) Distilled alcoholic beverages produced by amylolytic starter e.g., *shochu* of Japan, and *soju* of Korea (Steinkraus, 1996).
4) Alcoholic beverages produced by involvement of amylase in human saliva e.g., *chicha* of Peru (Vallejo et al., (2013).
5) Alcoholic beverages produced by mono- (single-strain) fermentation e.g., beer (Kurtzman and Robnet, 2003).
6) Alcoholic beverages produced from honey e.g., *tej* of Ethiopia (Bahiru et al., 2006).
7) Alcoholic beverages produced from plant parts e.g., *pulque* of Mexico (Lappe-Oliveras et al., 2008), *toddy* of India (Shamala and Sreekantiah, 1988) and *kanji* of India (Kingston et al., 2010).

8) Alcoholic beverages produced by malting (germination) e.g., *sorghum* (“*Bantu”)* beer of South Africa (Kutyauripo et al., 2009), *pito* of Nigeria and Ghana (Kolawole et al., 2013) and *tchoukoutou* of Benin (Greppi et al., 2013a).
9) Alcoholic beverages prepared from fruits without distillation (e.g., wine, cider).
10) Distilled alcoholic beverages prepared from fruits and cereals e.g., whisky and brandy.

Amylolytic starters

Traditional way of sub-cultuing of essential microorganisms (consortia of filamentous moulds, amylolytic and alcohol-producing yeasts and LAB) with rice or wheat as the base in the form of dry, flattened or round balls, for production of alcoholic beverages is a remarkable discovery in the food history of Asian people, which is exclusively practiced in South East Asia including the Himalayan regions of India, Nepal, Bhutan, and China (Tibet) (Hesseltine, 1983; Tamang, 2010a). Around 1–2% of previously prepared amylolytic starters are inoculated into the dough, and mixed cultures allowed to develop for a short time, then dried, and used to make either alcohol or fermented foods from starchy materials (Tamang et al., 2006). Asian amylolytic starters have different vernacular names such as *marcha* in India and Nepal, *hamei, humao, phab* in India, *mana* and *manapu* of Nepal, *men* in Vietnam, *ragi* in Indonesia, *bubod* in Philippines, *chiu/chu* in China and Taiwan, *loogpang* in Thailand, *mae/dombae /buh/puh* in Cambodia and *nuruk* in Korea (Hesseltine and Kurtzman, 1990;

Nikkuni et al., 1996; Sujaya et al., 2004; Thanh et al., 2008; Tamang et al., 2012; Yamamoto and Matsumoto, 2011).

Microbial profiles of amylolytic starters of India, Nepal and Bhutan are filamentous moulds (*Mucor circinelloides* forma *circinelloides*, *Mucor hiemalis*, *Rhi. chinensis*, and *Rhi. stolonifer* variety *lyococcus* (Tamang et al., 1988), yeasts (*Sacch. cerevisiae, Sacch. bayanus*, *Saccharomycopsis* (*Sm.*) *fibuligera, Sm. capsularis, Pichia anomala, Pic. burtonii,* and *Candida glabrata)* (Tamang and Sarkar, 1995; Shrestha et al., 2002; Tsuyoshi et al., 2005; Tamang et al., 2007; Jeyaram et al., 2008a, 2011; Chakrabarty et al., 2014), and LAB—*Ped. pentosaceus*, *Lb. bifermentans* and *Lb. brevis* (Hesseltine and Ray, 1988; Tamang and Sarkar, 1995; Tamang et al., 2007; Chakrabarty et al., 2014). In ethnic starter culture of Vietnam locally called *men* contains a diversity of yeasts (*Candida tropicalis*, *Clavispora lusitaniae, Pichia anomala*, *P. ranongensis, Saccharomycopsis fibuligera*, *Sacch. cerevisiae*, *Issatchenkia* sp.), filamentous moulds (*Absidia corymbifera*, *Amylomyces rouxii, Botryobasidium subcoronatum, Rhizopus oryzae*, *Rhi. microsporus*, *Xeromyces bisporus*); LAB (*Ped. pentosaceus*, *Lb. plantarum*, *Lb. brevis*, *Weissella confusa*, *W. paramesenteroides*)*,* amylase-producing bacilli (*Bacillus subtilis*, *B. circulans*, *B. amyloliquefaciens*, *B. sporothermodurans*), acetic acid bacteria (*Acetobacter orientalis*, *A. pasteurianus*) (Dung et al., 2006, 2007; Thanh et al., 2008).

A combination of *Asp. oryzae* and *Asp. sojae* is used in *koji* in Japan to produce alcoholic beverages including *saké* (Zhu and Trampe, 2013). *Koji* (Chinese *chu, shi* or *qu*) also produces amylases that convert starch to fermentable sugars, which are then used for the second stage yeast fermentation to make non-alcoholic fermented soybean *miso* and *shoyu* (Sugawara, 2010). *Asp. awamori, Asp. kawachii, Asp. oryzae, Asp. shirousamii,* and *Asp. sojae* have been widely used as the starter in preparation of *koji* for production of *miso, saké, shoyu, shochu* (Suganuma et al., 2007).

Non-distilled mild-alcoholic food beverages produced by amylolytic starters

The biological process of liquefaction and saccharification of cereal starch by filamentous moulds and yeasts, supplemented by amylolytic starters, under solid-state fermentation is one of the two major stages of production of alcoholic beverages in Asia (Tamang, 2010c). These alcoholic beverages are mostly considered as food beverage and eaten as staple food with high calorie in many parts of Asia, e.g., *kodo ko jaanr* of the Himalayan regions in India, Nepal, Bhutan and China (Tibet) with 5% alcohol content (Thapa and Tamang, 2004). Saccharifying activities are mostly shown by *Rhizopus* spp. and *Sm. fibuligera* whereas liquefying activities are shown by *Sm. fibuligera* and *Sacch. cerevisiae* (Thapa and Tamang, 2006). *Rhizopus*, *Amylomyces*, *Torulopsis*, and *Hansenula* are present in *lao-chao*, a popular ethnic fermented rice beverage of China (Wei and Jong, 1983). During fermentation of Korean *makgeolli* (prepared from rice by amylolytic starter *nuruk*) the proportion of the family *Saccharomycetaceae* increased significantly, and the major bacterial phylum of the samples shifted from γ-*Proteobacteria* to *Firmicutes* (Jung et al., 2012).

Non-distilled and filtered alcoholic beverages produced by amylolytic starters

Alcoholic beverages produced by amylolytic starter (*koji*) is not distilled but the extract of fermented cereals is filtered into clarified high alcohol-content liquor, eg *saké* which is a national drink of Japan containing 15 to 20% alcohol (Tamang, 2010c). Improved strains of *Asp. oryzae* are used for *saké* production in industrial scale (Hirasawa et al., 2009; Kotaka et al., 2008).

Distilled alcoholic beverages produced by amylolytic starters

This category of alcoholic drinks is the clear distillate of high alcohol content prepared as drink from fermented cereal beverages by using amylolytic starters. *Raksi* is an ethnic alcoholic (22-27% v/v) drink of the Himalayas with characteristic aroma, and distilled from the traditional fermented cereal beverages (Kozaki et al., 2000).

Alcoholic beverages produced by human saliva

Chicha is a unique ethnic fermented alcoholic (2-12% v/v) beverage of Andes Indian races of South America mostly in Peru, prepared from maize by human salivation process (Hayashida, 2008). *Sacch. cerevisiae, Sacch. apiculata, Sacch. pastorianus*, species of *Lactobacillus* and *Acetobacter* are present in *chicha* (Escobar et al., 1996). *Sacch. cerevisiae* was isolated from *chicha* and identified using MALDI-TOF (Vallejo et al., 2013). Species of *Lactobacillus,*

Bacillus, Leuconostoc, Enterococcus, Streptomyces, Enterobacter, Acinetobacter, Escherichia, Cronobacter, Klebsiella, Bifidobacterium and *Propioniobacterium* were reported from *chicha* of Brazil (Puerari et al., 2015).

Alcoholic beverages produced from honey

Some alcoholic beverages are produced from honey e.g., *tej* of Ethiopia. It is a yellow, sweet, effervescent and cloudy alcoholic (7-14% v/v) beverage (Steinkraus, 1996). *Sacch. cerevisiae, Kluyvermyces bulgaricus, Debaromyces phaffi*, and *Kl. veronae*, and LAB species of *Lactobacillus*, *Streptococcus*, *Leuconostoc* and *Pediococcus* are responsible for *tej* fermentation (Bahiru et al., 2006).

Alcoholic beverages produced from plant parts

Pulque is one of the oldest alcoholic beverages prepared from juices of the cactus (*Agave*) plant of Mexico (Steinkraus, 2002). Bacteria present during the fermentation of *pulque* were LAB (*Lc. lactis* subsp. *lactis*, *Lb. acetotolerans*, *Lb. acidophilus, Lb. hilgardii*, *Lb. kefir*, *Lb. plantarum, Leuc. citreum*, *Leuc. kimchi*, *Leuc. mesenteroides*, *Leuc. pseudomesenteroides*), the γ-Proteobacteria (*Erwinia rhapontici*, *Enterobacter* spp. and *Acinetobacter radioresistens,* several α-Proteobacteria), *Zymomonas mobilis, Acetobacter malorum, A. pomorium*, *Microbacterium arborescens*, *Flavobacterium johnsoniae*, *Gluconobacter oxydans*, and *Hafnia alvei* (Escalante et al., 2004, 2008). Yeasts isolated from *pulque* include

Saccharomyces (Sacch. bayanus, Sacch. cerevisiae, Sacch. paradoxus) and non-*Saccharomyces (Candida* spp.*, C. parapsilosis, Clavispora lusitaniae, Hanseniaspora uvarum, Kl. lactis, Kl. marxianus, Pichia membranifaciens, Pichia* spp.*, Torulaspora delbrueckii*) (Lappe-Oliveras et al., 2008).

Depending on the region, traditional alcoholic drinks prepared from palm juice called "palm wine" are known by various names, e.g., *toddy* or *tari* in India, *mu, bandji, ogogoro, nsafufuo, nsamba, mnazi, yongo, taberna, tua* or *tubak* in West Africa and South America (Ouoba et al., 2012). Microorganisms that are responsible for *toddy* fermentation are *Sacch. cerevisiae*, *Schizosaccharomyces pombe, Acetobacter aceti, A. rancens, A. suboxydans, Leuc. Dextranicum (mesenteroides), Micrococcus* sp., *Pediococcus* sp., *Bacillus* sp. and *Sarcina* sp. (Shamala and Sreekantiah, 1988).

Kanji is an ethnic Indian strong-flavoured mild alcoholic beverage prepared from beet-root and carrot by natural fermentation (Batra and Millner, 1974). *Hansenlu anomala, Candida guilliermondii, C. tropicalis, Geotrichium candidum, Leuc. mesenteroides, Pediococcus* sp., *Lb. paraplantarum* and *Lb. pentosus* are present in *kanji* (Batra and Millner, 1976; Kingston et al., 2010).

Alcoholic beverages produced by malting or germination

Bantu beer or sorghum beer of Bantu tribes of South Africa is an alcoholic beverage produced by malting or germination process (Taylor, 2003). Malted beer is common in Africa with different names e.g., as *bushera* or *muramba* in Uganda, *chibuku* in Zimbabwe, *dolo, burkutu* and *pito* in West Africa and *ikigage* in Rwanda (Lyumugabe et al., 2012; Muyanja et al., 2003; Sawadogo-Lingani et al., 2007). Sorghum (*Sorghum caffrorum* or *S. vulgare*) is malted and used for brewing the beer (Kutyauripo et al., 2009), characterised by a two-stage (lactic followed by alcoholic) fermentation, with *Lb. fermentum* as the dominating LAB species (Sawadogo-Lingani et al., 2007).

Alcoholic beverages produced from fruits without distillation

Common example of alcoholic beverages produced from fruits without distillation is wine which is initiated by the growth of various species of *Saccharomyces* and non-*Saccharomyces* (so-called "wild") yeasts (e.g. *Candida colliculosa, C. stellata, Hanseniaspora uvarum, Kloeckera apiculata, Kl. thermotolerans, Torulaspora delbrueckii*, *Metschnikowia pulcherrima*) (Moreira et al., 2005; Pretorius, 2000; Sun et al., 2014; Walker, 2014). *Candida* sp. and *Cladosporium* sp. were isolated from fermenting white wine using mCOLD-PCR-DGGE, but were not detected by conventional PCR (Takahashi et al., 2014). *Sacch. cerevisiae* strains develop during wine fermentations play an active role in the characteristics of wine (Capece et al., 2013). *Saccharomyces Genome Database* (SGD; www.yeastgenome.org) provides fee of charge access or links to comprehensive datasets comprising genomic, transcriptomic, proteomic and metabolomic information (Pretorius et al., 2015).

Conclusions

Every community in the world has distinct food culture including fermented foods and alcoholic beverages, symbolising the heritage and socio-cultural aspects of the ethnicity. The word 'culture' denotes food habits of ethnicity; another meaning for the same expression 'culture' is a cluster of microbial cells or inoculum, an essential biota for fermentation, fequstly used in the microbiology. The diversity of functional microorganisms ranges from filamentous moulds to enzyme-producing and alcohol-producing yeasts, and from Gram-positive to a few Gram-negative bacteria, while even *Archaea* has been ascribed a role in some fermented foods and alcoholic beverages. The relationship between human life and microorganisms benefits both in the natural process. However, consumption of some less known and uncommon ethnic fermented foods is declining due to change in life style, shifting from cultural food habits to commercial foodstuffs and fast foods, drastically effecting traditional culinary practices, and also due to climate change in some environments such as the Sahel region in Africa and vast areas adjacent to the Gobi desert in Asia.

References

Abe, M., Takaoka, N., Idemoto, Y., Takagi, C., Imai, T. and Nakasaki, K. (2008). Characteristic fungi observed in the fermentation process for Puer tea. *International Journal of Food Microbiology,* 124, 199–203.

Abriouel, H., Benomar, N., Lucas, R. and Gálvez, A. (2011). Culture-independent study of the diversity of microbial populations in brines during fermentation of naturally-fermented Aloreña green table olives. *International Journal of Food Microbiology*, 144, 487–496.

Abriouel, H., Omar, N.B., López, R.L., Martínez-Cañamero, M., Keleke, S. and Gálvez, A. (2006). Culture-independent analysis of the microbial composition of the African traditional fermented foods *poto poto* and *dégué* by using three different DNA extraction methods. *International Journal of Food Microbiology,* 111, 228-233.

Adams, M.R. (2010). Fermented meat products. In: Tamang J.P., Kailasapathy, K. (Eds.), Fermented Foods and Beverages of the World. CRC press, Taylor & Francis Group, New York, pp. 309–322.

Adams, M.R. (2014).Vinegar. In: Batt, C., Tortorello, M.A. (Eds.). Encyclopaedia of Food Microbiology, 2 edition, Elsevier Ltd., Oxford, pp. 717–721.

Ahaotu, I., Anyogu, A., Njoku, O.H., Odu, N.N., Sutherland, J.P. and Ouoba, L.I.I. (2013). Molecular identification and safety of *Bacillus* species involved in the fermentation of African oil beans (*Pentaclethra macrophylla* Benth) for production of Ugba. *International Journal of Food Microbiology,* 162, 95–104.

Aidoo, K.E. and Nout, M.J.R. (2010). Functional yeasts and molds in fermented foods and beverages, In: Tamang J.P., Kailasapathy, K. (Eds.), Fermented Foods and Beverages of the World. CRC press, Taylor & Francis Group, New York, 127–148.

Akabanda, F., Owusu-Kwarteng, J., Tano-Debrah, K., Glover, R.L.K., Nielsen, D.S. and Jespersen, L. (2013). Taxonomic and molecular characterization of lactic acid bacteria and yeasts in *nunu*, a Ghanaian fermented milk product. *Food Microbiology*, 34, 277–283.

Aksu, M.I., Kaya, M. and Ockerman, H.W. (2005). Effect of modified atmosphere packaging and temperature on the shelf life of sliced Pastirma produced from frozen/thawed meat. *Journal of Muscle Foods,* 16, 192–206.

Albano, H., van-Reenen, C.A., Todorov, S.D., Cruz, D., Fraga, L., Hogg, T., Dicks, L.M. and Teixeira, P. (2009). Phenotypic and genetic heterogeneity of lactic acid bacteria isolated from “Alheira”, a traditional fermented sausage produced in Portugal. *Meat Science*, 82, 389–398.

Alegría, A., González, R., Díaz, M. and Mayo, B. (2011). Assessment of microbial populations dynamics in a blue cheese by culturing and denaturing gradient gel electrophoresis. *Current Microbiology*, 62, 888–893.

Alexandraki, V., Tsakalidou, E., Papadimitriou, K. and Holzapfel, W. H. (2013). Status and trends of the conservation and sustainable use of microorganisms in food processes. Commission on Genetic Resources for Food and Agriculture. FAO Background Study Paper No. 65.

Amoa-Awua, W. K., Terlabie, N.N. and Sakyi-Dawson, E. (2006). Screening of 42 *Bacillus* isolates for ability to ferment soybeans into *dawadawa*. *International Journal of Food Microbiology*, 106, 343–347.

Angelakis, E., Million, M., Henry, M. and Raoult, D. (2011). Rapid and accurate bacterial identification in probiotics and yoghurts by MALDI-TOF mass spectrometry. *Journal of Food Science,* 76, M568–572.

Asahara, N., Zhang, X.B. and Ohta, Y. (2006). Antimutagenicity and mutagen-binding activation of mutagenic pyrolyzates by microorganisms isolated from Japanese *miso. Journal of the Science of Food and Agriculture*, 58, 395–401.

Axelsson, L., Rud, I., Naterstad K, Blom H, Renckens B, Boekhorst J, Kleerebezem M, van Hijum, S. and Siezen, R.J. (2012). Genome sequence of the naturally plasmid-free

Lactobacillus plantarum strain NC8 (CCUG 61730). *Journal of Bacteriology*, 194, 2391–2392.

Azokpota, P., Hounhouigan, D.J. and Nago, M.C. (2006). Microbiological and chemical changes during the fermentation of African locust bean (*Parkia biglobosa*) to produce afitin, iru, and sonru, three traditional condiments produced in Benin. *International Journal of Food Microbiology,* 107, 304–309.

Bahiru, B., Mehari, T. and Ashenafi, M. (2006). Yeast and lactic acid flora of *tej*, an indigenous Ethiopian honey wine: Variations within and between production units. *Food Microbiology,* 23, 277–282.

Batra, L.R., Millner, P.D. 1974. Some Asian fermented foods and beverages and associated fungi. Mycologia 66, 942–950.

Batra, L.R. and Millner, P.D. (1976). Asian fermented foods and beverages. Developments in *Industrial Microbiology*, 17, 117–128.

Bernardeau, M., Guguen, M. and Vernoux, J.P. (2006). Beneficial lactobacilli in food and feed: long-term use, biodiversity and proposals for specific and realistic safety assessments. *FEMS Microbiology Reviews*, 30, 487–513.

Blandino, A., Al-Aseeri, M.E., Pandiella, S.S., Cantero, D. and Webb, C. (2003). Cereal-based fermented foods and beverages. *Food Research Intern*ational, 36, 527–543.

Bourdichon, F., Casaregola, S., Farrokh, C., Frisvad, J.C., Gerds, M.L., Hammes, W.P., Harnett, J., Huys, G., Laulund, S., Ouwehand, A., Powell, I.B., Prajapati, J.B., Seto, Y., Schure, E.T., Van Boven, A., Vankerckhoven, V., Zgoda, A., Tuijtelaars, S. and Hansen, E.B. (2012). Food fermentations: microorganisms with technological beneficial use. *International Journal of Food Microbiology*, 154, 87–97.

Campbell-Platt, G. (1987). Fermented Foods of the World: A Dictionary and Guide. Butterworths, London.

Campbell-Platt, G. 1994. Fermented foods - a world perspective. *Food Research International,* 27, 253–257.

Capece, A., Siesto, G., Poeta, C., Pietrafesa, R. and Romano, P. (2013). Indigenous yeast population from Georgian aged wines produced by traditional "Kakhetian" method. *Food Micr*obiology, 36, 447–455.

Chakrabarty, J., Sharma, G.D., Tamang, J.P. 2014. Traditional technology and product characterization of some lesser-known ethnic fermented foods and beverages of North Cachar Hills District of Assam. Indian Journal of Traditional Knowledge 13 (4), 706-715.

Chang, H.W., Kim, K.H., Nam, Y.D., Roh, S.W., Kim, M.S., Jeon, C.O., Oh, H.M., Bae, J,W. 2008. Analysis of yeast and archaeal population dynamics in kimchi using denaturing gradient gel electrophoresis. International. Journal of Food Microbiology 126, 159–166.

Chao, S.H., Tomii, Y., Watanabe, K., Tsai and Y.C. (2008). Diversity of lactic acid bacteria in fermented brines used to make stinky tofu. *International Journal of Food Microbiology*, 123, 134–141.

Chao, S.H., Kudo, Y., Tsai, Y.C., Watanabe, K. 2012. *Lactobacillus futsaii* sp. nov., isolated from traditional fermented mustard products of Taiwan, fu-tsai and suan-tsai. International Journal of Systematic and Evoltionary Microbiology 62, 489–494.

Chao, S.H., Wu, R.J., Watanabe, K., Tsai, Y.C. 2009. Diversity of lactic acid bacteria in *suan-tsai* and *fu-tsai*, traditional fermented mustard products of Taiwan. International Journal of Food Microbiology 135, 203–210.

Chaves-López, C., Serio, A., Grande-Tovar, C.D., Cuervo-Mulet, R., Delgado-Ospina J., Paparella, A. (2014). Traditional fermented foods and beverages from a microbiological and nutritional perspective: the Colombian heritage. Comprehensive Reviews in Food Science and Food Safety 13, 1031–1048.

Chen, B., Wu, Q., Xu, Y. 2014. Filamentous fungal diversity and community structure associated with the solid state fermentation of Chinese *Maotai*-flavor liquor. International Journal of Food Microbiology 179, 80–84.

Chen, Y.S., Yanagida, F., Hsu, J.S. 2006. Isolation and characterization of lactic acid bacteria from *suan-tsai* (fermented mustard), a traditional fermented food in Taiwan. Journal of Applied Microbiology 101, 125–130.

Chen, Y.S., Wu, H.C., Liu, C.H., Chen, H.C., Yanagida, F. 2010. Isolation and characterization of lactic acid bacteria from jiang-sun (fermented bamboo shoots), a traditional fermented food in Taiwan. Journal of the Science of Food and Agriculture 90, 1977–1982.

Chen, Y.S., Wu, H.C., Lo, H.Y., Lin, W.C., Hsu, W.H., Lin, C.W., Lin, P.Y., Yanagida, F. 2012. Isolation and characterisation of lactic acid bacteria from *jiang-gua* (fermented cucumbers), a traditional fermented food in Taiwan. Journal of the Science of Food and Agriculture 92, 2069–2075.

Chettri, R., Tamang, J.P. 2008. Microbiological evaluation of maseura, an ethnic fermented legume-based condiment of Sikkim. Journal of Hill Research 21, 1–7.

Chettri, R., Tamang, J.P. 2015. *Bacillus* species isolated from *Tungrymbai* and *Bekang,* naturally fermented soybean foods of India. International Journal of Food Microbiology 197, 72–76.

Chinte-Sanchez, P. 2008. Philippine fermented foods: Principles and technology. The University of the Philippines Press, Quezon.

Choi, S.H., Lee, M.H., Lee, S.K., Oh, M.J. 1995. Microflora and enzyme activity of conventional *meju* and isolation of useful mould. Journal of Agricultural Science Chungnam National University, Korea, 22, 188–197.

Choi, U.K., Kim, M.H., Lee, N.H. 2007. The characteristics of cheonggukjang, a fermented soybean product, by the degree of germination of raw soybeans. Food Science and Biotechnology 16, 734–739.

Chokesajjawatee, N., Pornaem, S., Zo, Y.G., Kamdee, S., Luxananil, P., Wanasen, S., Valysevi, R. 2009. Incidence of *Staphylococcus aureus* and associated risk factors in Nham, a Thai fermented pork product. Food Microbiology 26, 547–551.

Chunhachart, O., Itoh, T., Sukchotiratana, M., Tanimoto, H., Tahara, Y. 2006. Characterization of γ-glutamyl hydrolase produced by *Bacillus* sp. isolated from Thai thua-nao. Bioscience, Biotechnology and Biochemistry 70, 2779–2782.

Cocolin, L., Dolci, P., Rantsiou, K. 2011. Biodiversity and dynamics of meat fermentations: The contribution of molecular methods for a better comprehension of a complex ecosystem. Meat Science 89, 296–302.

Cocolin, L., Aggio, D., Manzano, M., Cantoni, C., Comi, G. 2002. An application of PCR-DGGE analysis to profile the yeast populations in raw milk. International Dairy Journal 12, 407–411.

Cocolin, L., Alessandria, V., Dolci, P., Gorra, R., Rantsiou, R. 2013.Culture independent methods to assess the diversity and dynamics of microbiota during food fermentation. International Journal of Food Microbiology 167, 29–43.

Cocolin, L., Ercolini, D. (Eds). 2008. Molecular Techniques in the Microbial Ecology of Fermented Foods. Springer, New York.

Coppola, S., Fusco, V., Andolfi, R., Aponte, M., Aponte, M., Blalotta, G., Ercolini, D., Moschett,i G. 2006. Evaluation of microbial diversity during the manufacture of Fior di Latte di Agerola, a traditional raw milk pasta-filata cheese of the Naples area. Journal of Dairy Research 73, 264–272.

Corsetti, A., Settanni, L. 2007. Lactobacilli in sourdough fermentation. Food Research International 40, 539–558.

Coton, E., Desmonts ,M.H., Leroy, S., Coton, M., Jamet, E., Christieans, S., Donnio, P.Y., Lebert, I., Talon, R. 2010. Biodiversity of coagulase-negative staphylococci in French cheeses, dry fermented sausages, processing environments and clinical samples. International Journal of Food Microbiology 137, 221–229.

Dajanta, K., Chukeatirote, E., Apichartsrangkoon, A., Frazier, R.A. 2009. Enhanced aglycone production of fermented soybean products by *Bacillus* species. Acta Biologica Szegediensis 53, 93–98.

Dajanta, K., Apichartsrangkoon, A., Chukeatirote, E., Richard, A., Frazier, R.A. 2011. Free-amino acid profiles of *thua nao,* a Thai fermented soybean. Food Chemistry 125, 342–347.

Dalmacio, L.M.M., Angeles, A.K.J., Larcia, L.L.H., Balolong, M., Estacio, R. 2011. Assessment of bacterial diversity in selected Philippine fermented food products through PCR-DGGE. Beneficial Microbes 2, 273–281.

de Bruyne, K., Camu, N., Lefebvre, K., De Vuyst, L., Vandamme, P. 2008a. *Weissella ghanensis* sp. nov., isolated from a Ghanaian cocoa fermentation. International Journal of Systematic and Evoltionary Microbiology 58, 2721–2725.

de Bruyne, K., Franz, C.M., Vancanneyt, M., Schillinger, U., Mozzi, F., de Valdez, G.F., de Vuyst, L., Vandamme, P. 2008b. *Pediococcus* argentinicus sp. nov. from Argentinean fermented wheat flour and identification of *Pediococcus* species by pheS, rpoA and atpA sequence analysis. International Journal of Systematic and Evoltionary Microbiology 58, 2909–2916.

de Bruyne, K., Camu, N., De Vuyst, L., Vandamme, P. 2009. *Lactobacillus fabifermentans* sp. nov. and *Lactobacillus cacaonum* sp. nov., isolated from Ghanaian cocoa fermentations International Journal of Systematic and Evoltionary Microbiology 59, 7–12.

de Bruyne, K., Camu, N., de Vuyst, L., Vandamme, P. 2010. *Weissella fabaria* sp. nov., from a Ghanaian cocoa fermentation. International Journal of Systematic and Evoltionary Microbiology 60, 1999–2005.

de Bruyne, K., Schillinger, U., Caroline, L., Boehringer, B., Cleenwerck , I., Vancanneyt, M., De Vuyst, L., Franz, C.M., Vandamme, P. 2007. *Leuconostoc holzapfelii* sp. nov., isolated from Ethiopian coffee fermentation and assessment of sequence analysis of housekeeping genes for delineation of *Leuconostoc* species. International Journal of Systematic and Evoltionary Microbiology 57, 2952–2959.

Desfossés-Foucault, E., Dussault-Lepage, V., Le Boucher, C., Savard, P., LaPointe, G., Roy, D. 2012. Assessment of probiotic viability during Cheddar cheese manufacture and ripening using propidium monoazide-PCR quantification. Frontiers in Microbiology, 3, 1–11.

de Vuyst, L., Vrancken, G., Ravyts, F., Rimaux, T., Weckx , S. 2009. Biodiversity, ecological determinants, and metabolic exploitation of sourdough microbiota. Food Microbiology 26, 666–675.

Dewan, S., Tamang, J.P. 2006. Microbial and analytical characterization of *Chhu*, a traditional fermented milk product of the Sikkim Himalayas. Journal of Scientific & Industrial Research 65, 747–752.

Dewan, S., Tamang, J.P. 2007. Dominant lactic acid bacteria and their technological properties isolated from the Himalayan ethnic fermented milk products. Antonie van Leeuwenhoek 92, 343–352.

de Vuyst, L., Vrancken, G., Ravyts, F., Rimaux, T., Weckx, S. 2009. Biodiversity, ecological determinants, and metabolic exploitation of sourdough microbiota. Food Microbiology 26, 666–675.

Diancourt, L., Passet, V., Chervaux, C., Garault, P., Smokvina, T., Brisse, S. 2007. Multilocus sequence typing of *Lactobacillus casei* reveals a clonal population structure with low levels of homologous recombination. Applied and Environmental Microbiology 73, 6601–6611.

Dirar, H.A., Harper, D.B., Collins, M.A. 2006. Biochemical and microbiological studies on kawal, a meat substitute derived by fermentation of *Cassia obtusifolia* leaves. Journal of the Science of Food and Agriculture 36, 881–892.

Dolci, P., Alessandria, V., Rantsiou, K., Cocolin, L. 2015. Advanced methods for the identification, enumeration, and characterization of microorganisms in fermented foods. In: Advances in Fermented Foods and Beverages (Ed.) Holzapfel, W.H., Elsevier, London, 157–176.

Donovan, S.M., Shamir, R. 2014. Introduction to the yogurt in nutrition initiative and the first global summit on the health benefits of yogurt. The American Journal of Clinical Nutrition, 99, 1209S–1211S.

Doyle, M.P., Beuchat, L.R. 2013. Food Microbiology: Fundamentals and Frontiers, 4th edition. ASM Press, Washington DC.

Dung, N.T.P., Rombouts, F.M., Nout, M.J.R. 2006. Functionality of selected strains of moulds and yeasts from Vietnamese rice wine starters. Food Microbiology 23, 331–340.

Dung, N.T.P., Rombouts, F.M., Nout, M.J.R. 2007. Characteristics of some traditional Vietnamese starch-based rice wine starters (*Men*). LWT - Food Science and Technology 40, 130–135.

Dušková, M., Šedo, O., Kšicová, K., Zdráhal, Z., Karpíšková, R. 2012. Identification of lactobacilli isolated from food by genotypic methods and MALDI-TOF MS. International Journal of Food Microbiology 159, 107–114.

Endo, A., Mizuno, H., Okada, S. 2008. Monitoring the bacterial community during fermentation of sunki, an unsalted, fermented vegetable traditional to the Kiso area of Japan. Letters in Applied Microbiology 47, 221–226.

Encinas, J.P., Lopez-Diaz, T.M., Garcia-Lopez, M.L., Otero, A. and Moreno, B. 2000. Yeast populations on Spanish fermented sausages. Meat Science 54: 203–208.

Ercolini, D. 2004. PCR-DGGE fingerprinting: novel strategies for detection of microbes in food. Journal of Microbiological Methods 56, 297–314.

Escalante, A., Giles-Gómez, M., Hernández, G., Córdova-Aguilar, M.S., López-Munguía, A., Gosset, G., Bolívar, F. 2008. Analysis of bacterial community during the fermentation of pulque, a traditional Mexican alcoholic beverage, using a polyphasic approach. International Journal of Food Microbiology 124, 126–134.

Escalante, A., Rodríguez, M.E., Martínez, A., López-Munguía, A., Bolívar, F., Gosset, G. 2004. Characterization of bacterial diversity in *Pulque*, a traditional Mexican alcoholic fermented beverage, as determined by 16S rDNA analysis. FEMS Microbiology Letters 2, 273–279.

Escobar, A., Gardner, A., Steinkraus, K.H. 1996. Studies of South American chichi. In: *Handbook of Indigenous Fermented Food*, 2nd edition, Steinkraus K.H.(Ed.) Marcel Dekker, Inc., New York, 402–406.

Farhad, M., Kailasapathy, K., Tamang, J.P. 2010. Health aspects of fermented foods, In:Tamang J.P., Kailasapathy K. (Eds.) Fermented Foods and Beverages of the World, CRC Press, Taylor & Francis Group, New York, 391–414.

F.A.O. 1999. Fermented Cereals.A Global Perspective. FAO Agricultural Services Bulletin No. 138.

Feng, X.M., Eriksson, A.R.B., Schnürer, J. 2005. Growth of lactic acid bacteria and *Rhizopus oligosporus* during barley tempeh fermentation. International Journal of Food Microbiology 104, 249–256.

Fleming, H.P. 1984. Developments in cucumber pickling fermentation. Journal of Chemical Technology and Biotechnology 34B, 241–252.

Flórez, A.B., Mayo, B. 2006. Microbial diversity and succession during the manufacture and ripening of traditional, Spanish, blue-veined Cabrales cheese, as determined by PCR261 DGGE. International Journal of Food Microbiology 110, 165–171.

Franz, C.M.A.P., Huch, M., Mathara, J.M., Abriouel, H., Benomar, N., Reid, G., Galvez, A., Holzapfel, W.H. 2014. African fermented foods and probiotics. International Journal of Food Microbiology 190, 84-96.

Fujimoto, J., Watanabe, K. 2013. Quantitative detection of viable *Bifidobacterium bifidum* BF-1 in human feces by using propidium monoazide and strain-specific primers. Applied Environmental Microbiology 79, 2182–2188.

Ganasen, P., Benjakul, S. 2010. Physical properties and microstructure of pidan yolk as affected by different divalent and monovalent cations. LWT - Food Science and Technology 43, 77–85.

Gänzle, M.G., Ehmann, M., Hammes, W.P. 1998. Modeling of growth of *Lactobacillus sanfranciscensis* and *Candida milleri* in response to process parameters of sourdough fermentation. Applied and Environment Microbiology 64, 2616–2623.

Garcia-Fontan, M.C., Lorenzo, J.M., Parada, A., Franco, I., Carballo, J. 2007. Microbiological characteristics of "Androlla", a Spanish traditional pork sausage. Food Microbiology 24, 52–58.

Giraffa, G., Carminati, D. 2008. Molecular techniques in food fermentation: principles and applications. In: Cocolin, L. Ercolini, D. (Eds.) *Molecular Techniques in the Microbial Ecology of Fermented Foods*. Springer Science+Business Media, LCC, New York. Chapter 1, pp. 1–30.

Ghosh, J., Rajorhia, G.S. 1990. Selection of starter culture for production of indigenous fermented milk product (*Misti dahi*). Lait 70, 147–154.

Greppi, A., Rantsiou, K., Padonou, W., Hounhouigan, J., Jespersen, L., Jakobsen, M., Cocolin, L. 2013a. Determination of yeast diversity in ogi, mawè, gowé and tchoukoutou by using culture-dependent and -independent methods. International Journal of Food Microbiology 165, 84–88.

Greppi, A., Rantsiou, K., Padonou, W., Hounhouigan, J., Jespersen, L., Jakobsen, M., Cocolin, L. 2013b. Yeast dynamics during spontaneous fermentation of mawè and tchoukoutou, two traditional products from Benin. International Journal of Food Microbiology 165, 200–207.

Guan, L., Cho, K.H., Lee, J.H. 2011. Analysis of the cultivable bacterial community in *jeotgal*, a Korean salted and fermented seafood, and identification of its dominant bacteria. Food Microbiology, 28, 101–113.

Gupta, M., Khetarpaul, N., Chauhan, B.M. 1992. Rabadi fermentation of wheat: changes in phytic acid content and in vitro digestibility. Plant Foods For Human Nutrition 42, 109–116.

Gupta, R.C., Mann, B., Joshi, V.K., Prasad, D.N. 2000. Microbiological, chemical and ultrastructural characteristics of misti doi (sweetened dahi). Journal of Food Science and Technology 37, 54–57

Guyot, J.P. 2010. Fermented cereal products, In: Tamang, J. P., Kailasapathy, K. (Eds) Fermented Foods and Beverages of the World, CRC Press, Taylor & Francis Group, New York, 247–261.

Hamad, S.H., Dieng, M.M.C., Ehrmann, M.A., Vogel, R.F. 1997. Characterisation of the bacterial flora of Sudanese sorghum flour and sorghum sourdough. Journal of Applied Microbiology 83, 764–770.

Hammes, W.P., Brandt, M.J., Francis, K.L., Rosenheim, J., Seitter, M.F.H., Vogelmann, S.A. 2005. Microbial ecology of cereal fermentations. Trends in Food Science and Technology 16, 4–11.

Han, B.Z., Beumer, R.R., Rombouts, F.M., Nout, M.J.R. 2001. Microbiological safety and quality of commercial sufu- a Chinese fermented soybean food. Food Control 12, 541–547.

Hao, Y., Zhao, L., Zhang, H., Zhai, Z. 2010. Identification of the bacterial biodiversity in koumiss by denaturing gradient gel electrophoresis and species-specific polymerase chain reaction. Journal of Dairy Science 93, 1926–1933.

Hara, T., Chetanachit, C., Fujio, Y., Ueda, S. 1986. Distribution of plasmids in polyglutamate-producing *Bacillus* strains isolated from “natto”–like fermented soybeans, “thua nao,” in Thailand. Journal of General and Applied Microbiology 32, 241–249.

Hara, T., Hiroyuki, S., Nobuhide, I., Shinji, K. 1995. Plasmid analysis in polyglutamate-producing *Bacillus* strain isolated from non-salty fermented soybean food, “kinema”, in Nepal. Journal of General and Applied Microbiology 41, 3–9.

Harun-ur-Rashid, M., Togo, K., Useda, M., Miyamoto, T. 2007. Probiotic characteristics of lactic acid bacteria isolated from traditional fermented milk “Dahi” in Bangladesh. Pakistan Journal of Nutrition 6, 647–652.

Haruta, S., Ueno, S., Egawa, I., Hashiguchi, K., Fujii, A., Nagano, M., Igarashi, Y.l. 2006. Succession of bacterial and fungal communities during a traditional pot fermentation of rice vinegar assessed by PCR-mediated denaturing gradient gel electrophoresis. International Journal of Food Microbiology 79–87.

Hayashida, F.M. 2008. Ancient beer and modern brewers: Ethnoarchaeological observations of *chicha* production in two regions of the North Coast of Peru. Journal of Anthropological Archaeology 27, 161–174

Hesseltine, C.W. 1965. A millenium of fungi, food and fermentation. Mycologia 57, 149-197.

Hesseltine, C.W. 1979. Some important fermented foods of Mid-Asia, the Middle East, and Africa. Journal of American Oil Chemists’ Society 56, 367–374.

Hesseltine, C.W. (1983). Microbiology of oriental fermented foods. *Annual Review of Microbiology* 37, 575–601.

Hesseltine, C.W., Kurtzman, C.P. 1990. Yeasts in amylolytic food starters. Anales del instituto de biologia de la universidad nacional autonoma de Mexico. Serie Botanica 60, 1–7.

Hesseltine, C.W., Ray, M.L. 1988. Lactic acid bacteria in murcha and ragi. Journal of Applied Bacteriology 64, 395–401.

Hesseltine, C.W., Wang, H.L. 1967. Traditional fermented foods. Biotechnology and Bioengineering 9, 275–288.

Hirasawa, T., Yamada, K., Nagahisa, K., Dinh, T.N., Furusawa, C., Katakura, Y., Shioya, S., Shimizu, H. 2009. Proteomic analysis of responses to osmotic stress in laboratory and sake-brewing strains of *Saccharomyces cerevisiae*. Process Biochemistry 44, 647–653.

Ho, C.C. 1986. Identity and characteristics of *Neurospora intermedia* responsible for *oncom* fermentation in Indonesia. Food Microbiology 3, 115–132.

Holzapfel, W.H. 1997. Use of starter cultures in fermentation on a household scale. Food Control 8, 241–258.

Holzapfel, W. 2002. Appropriate starter culture technologies for small-scale fermentation in developing countries. International Journal of Food Microbiology 75, 197–212.

Holzapfel, W.H., Harberer, P., Snel, J., Schillinger, U., Huis in't Veld, J.H.J. 1998. Overview of gut flora and probiotics. International Journal of Food Microbiology 41, 85–101.

Holzapfel, W.H., Wood, B.J.B. 2014. Lactic Acid Bacteria: Biodiversity and Taxonomy. Wiley-Blackwell, p 632.

Hong, S.W., Choi, J.Y., Chung, K.S. 2012. Culture-based and denaturing gradient gel electrophoresis analysis of the bacterial community from chungkookjang, a traditional Korean fermented soybean food. Journal of Food Science 77, M572–578.

Hosono, A., Wardoyo, R., Otani, H. (1989). Microbial flora in "dadih", a traditional fermented milk in Indonesia. *Lebensm-Wiss u-Technol* 22: 20-24.

Humblot, C., Guyot, J.P. 2009. Pyrosequencing of tagged 16S rRNA gene amplicons for rapid deciphering of the microbiomes of fermented foods such as pearl millet slurries. Applied and Environmental Microbiology 75, 4354–4361.

Hwanhlem, N., Buradaleng, S., Wattanachant, S., Benjakul, S., Tani, A., Maneerat, S. 2011. Isolation and screening of lactic acid bacteria from Thai traditional fermented fish (*Plasom*) and production of *Plasom* from selected strains.Food Control 22, 401–407.

Iacumin, L., Cecchini, F., Manzano, M., Osualdini, M., Boscolo, D., Orlic, S., Comi, G. 2009. Description of the microflora of sourdoughs by culture-dependent and culture-independent methods. Food Microbiology 26, 128–135.

Ijong, F.G., Ohta, Y. 1996. Physicochemical and microbiological changes associated with bakasang processing - a traditional Indonesian fermented fish sauce. Journal of the Science of Food and Agriculture 71, 69–74.

Inatsu, Y., Nakamura, N., Yuriko, Y., Fushimi, T., Watanasritum, L., Kawanmoto, S. 2006. Characterization of *Bacillus subtilis* strains in Thua nao, a traditional fermented soybean food in northern Thailand. Letters in Applied Microbiology 43, 237–242.

Itoh, H., Tachi, H., Kikuchi, S. 1993. Fish fermentation technology in Japan. In: Lee, C.H., Steinkraus, K.H. and Alan Reilly, P.J. (Eds.) *Fish Fermentation Technology* pp. 177–186. United Nations University Press, Tokyo.

Jagannath, A., Raju, P.S., Bawa, A.S. 2010. Comparative evaluation of bacterial cellulose (natta) as a cryoprotectant and carrier support during the freeze drying process of probiotic lactic acid bacteria. LWT - Food Science and Technology 43, 1197–1203.

Jeng, K.C., Chen, C.S., Fang, Y.P., Hou, R.C.W., Chen, Y.S. 2007. Effect of microbial fermentation on content of statin, GABA, and polyphenols in Puerh tea. Journal of Agricultural and Food Chemistry 55, 8787–8792.

Jennessen, J., Schnürer, J., Olsson, J., Samson, R.A., Dijiksterhuis, J. 2008. Morphological characteristics of sporangiospores of the tempe fungus *Rhizopus oligosporus* differentiate it from other taxa of the *R. microsporus* group. Mycological Research 112, 547–563.

Jeyaram, K., Romi, W., Singh, T. Ah., Devi, A.R., Devi, S.S. 2010**.** Bacterial species associated with traditional starter cultures used for fermented bamboo shoot production in Manipur state of India. International Journal of Food Microbiology 143, 1–8.

Jeyaram, K., Mohendro Singh, W., Capece, A., Romano, P. 2008a. Molecular identification of yeast species associated with 'Hamei"- a traditional starter used for rice wine production in Manipur, India. International Journal of Food Microbiology 124, 115–125.

Jeyaram, K., Mohendro Singh, W., Premarani, T., Ranjita Devi, A., Selina Chanu, K., Talukdar, N.C., Rohinikumar Singh, M. 2008b. Molecular Identification of dominant microflora associated with 'Hawaijar' – a traditional fermented soybean (*Glycine max* L.) food of Manipur, India. International Journal of Food Microbiology 122, 259–268.

Jeyaram, K., Tamang, J.P., Capece, A., Romano, P.P. 2011. Geographical markers for *Saccharomyces cerevisiae* strains with similar technological origins domesticated for rice-based ethnic fermented beverages production in North East India. Antonie van Leeuwenhoek 100, 569–578.

Jianzhonga, Z., Xiaolia, L., Hanhub, J., Mingshengb, D. 2009. Analysis of the microflora in Tibetan kefir grains using denaturing gradient gel electrophoresis. Food Microbiology 26, 770–775.

Johanningsmeier, S., McFeeters, R.F., Fleming, H.P., Thompson, R.L. 2007. Effects of *Leuconostoc mesenteroides* starter culture on fermentation of cabbage with reduced salt concentrations. Journal of Food Science 72, M166–M172.

Johnson, E.A., Echavarri-Erasun, C. 2011. Yeast Biotechnology. In: Kurtzman, C., Fell, J.W., Boekhout, T. (editors) *The Yeasts: A Taxonomic Study* (5th edition) (Elsevier) 1: 23.

Josephsen, J., Jespersen, L. 2004. Handbook of Food and Beverage Fermentation Technology. In: Hui, Y.H., Meunier-Goddik, L., Hansen, Å.S., Josephsen, J., Nip, W.K., Stanfield, P.S., Toldrá, F. (Eds). Starter Cultures and Fermented Products, Marcel Dekker, Inc., 270 Madison Avenue, New York, 3, pp. 23–49.

Jung, J.Y., Lee, S.H., Kim, J.M., Park, M.S., Bae, J.W., Hahn, Y., Madsen, E.L., Jeon, C.O. 2011. Metagenomic analysis of kimchi, a traditional Korean fermented food. Applied and Environment Microbiology 77, 2264–2274.

Jung, J.Y., Lee, S.H., Jin, H.M., Hahn, Y., Madsen, E.L., Jeon, C.O. 2013a. Metatranscriptomic analysis of lactic acid bacterial gene expression during *kimchi* fermentation. International Journal of Food Microbiology 163, 171–179.

Jung, J.Y., Lee, S.H., Lee, H.J., Jeon, C.O. 2013b. Microbial succession and metabolite changes during fermentation of saeu-jeot: Traditional Korean salted seafood. Food Microbiology 34, 360–368.

Jung, M.J., Nam, Y.D., Roh, S.W., Bae, J.W. 2012. Unexpected convergence of fungal and bacterial communities during fermentation of traditional Korean alcoholic beverages inoculated with various natural starters. Food Microbiology 30, 112–123.

Kahala, M., Mäki, M., Lehtovaara, A., Tapanainen, J.M., Katiska, R., Juuruskorpi, M., Juhola, J., Joutsjoki, V. 2008. Characterization of starter lactic acid bacteria from the Finnish fermented milk product viili. Journal of Applied Microbiology 105, 1929–1938.

Karki, T., Okada, S., Baba, T., Itoh, H., Kozaki, M. 1983. Studies on the microflora of Nepalese pickles gundruk. Nippon Shokuhin Kogyo Gakkaishi 30, 357–367.

Khanh, T.M., May, B.K., Smooker, P.M., Van, T.T.H., Coloe, P.J. 2011. Distribution and genetic diversity of lactic acid bacteria from traditional fermented sausage. Food Research International 44, 338–344.

Kiers, J.L., Van laeken, A.E.A., Rombouts, F.M., Nout, M.J.R. 2000. In vitro digestibility of *Bacillus* fermented soya bean. International Journal of Food Microbiology 60, 163–169.

Kim, T.W., Lee, J.W., Kim, S.E., Park, M.H., Chang, H.C., Kim, H.Y. 2009. Analysis of microbial communities in *doenjang*, a Korean fermented soybean paste, using nested PCR-denaturing gradient gel electrophoresis. International Journal of Food Microbiology 131, 265–271.

Kim, Y.B., Seo, Y.G., Lee, C.H. 1993. Growth of microorganisms in dorsal muscle of gulbi during processing and their effect on its quality. In: Lee, C.H., Steinkraus, K.H. and Alan Reilly, P.J. (Eds.), Fish Fermentation Technology, United Nations University Press, Tokyo. pp. 281–289

Kimura, K., Itoh, Y. 2007. Determination and characterization of IS*4Bsu1*-insertion loci and identification of a new insertion sequence element of the IS256 family in a natto starter. Bioscience Biotechnology and Biochemistry 71, 2458–2464.

Kingston, J.J., Radhika, M., Roshini, P.T., Raksha, M.A., Murali, H.S., Batra, H.V. 2010. Molecular characterization of lactic acid bacteria recovered from natural fermentation of beet root and carrot Kanji. Indian Journal of Microbiology 50, 292–298.

Kiyohara, M., Koyanagi, T., Matsui, H., Yamamoto, K., Take, H., Katsuyama, Y., Tsuji, A., Miyamae, H., Kondo, T., Nakamura, S., Katayama, T., Kumagai, H. 2012. Changes in microbiota population during fermentation of Narezushi as revealed by pyrosequencing analysis. Bioscience Biotechnology and Biochemistry 76, 48–52.

Kobayashi, T., Kimura, B. and Fujii, T. (2000a). Strictly anaerobic halophiles isolated from canned Swedish fermented herrings (Surströmming). *International Journal of Food Microbiology*, 54, 81–89.

Kobayashi, T., Kimura, B. and Fujii, T. (2000b). *Haloanaerobium fermentans* sp. nov., a strictly anaerobic, fermentative halophile isolated from fermented puffer fish ovaries. *International Journal of Systematic and Evolutionary Microbiology,* 50, 1621–1627.

Kobayashi, T., Kimura, B. and Fujii, T. (2000c). Differentiation of *Tetragenococcus* populations occurring in products and manufacturing processes of puffer fish ovaries fermented with rice-bran. *International Journal of Food Microbiology*, 56, 211–218.

Kolawole, O.M., Kayode, R.M.O. and Akinduyo, B. (2013). Proximate and microbial analyses of burukutu and pito produced in Ilorin, Nigeria. *African Journal of Microbiology* ,1, 15–17.

Kotaka, A., Bando, H., Kaya, M., Kato-Murai, M., Kuroda, K., Sahara, H., Hata, Y., Kondo, A. and Ueda, M. (2008). Direct ethanol production from barley β-glucan by sake yeast displaying *Aspergillus oryzae* β-glucosidase and endoglucanase. *Journal of Bioscience and Bioengineering,* 105, 622–627.

Kozaki, M. (1976). Fermented foods and related microorganisms in Southeast Asia. *Journal of Applied Mycotoxicology,* 2, 1–9.

Kozaki, M., Tamang, J.P., Kataoka, J., Yamanaka, S. and Yoshida, S. (2000). Cereal wine *(jaanr)* and distilled wine *(raksi)* in Sikkim. *Journal of the Brewing Society of Japan*, 95, 115–122.

Kubo, Y., Rooney, A.P., Tsukakoshi, Y., Nakagawa, R., Hasegawa, H. and Kimura, K. (2011). Phylogenetic analysis of *Bacillus subtilis* Strains applicable to natto (fermented soybean) production. *Applied and Environmental Microbiology*, 77, 6463–6469.

Kuda, T., Izawa, Y., Yoshida, S., Koyanagi, T., Takahashi, H. and Kimura, B. (2014). Rapid identification of *Tetragenococcus halophilus* and *Tetragenococcus muriaticus*, important species in the production of salted and fermented foods, by matrix-assisted laser desorption ionization-time of flight mass spectrometry (MALDI-TOF MS). *Food Control,* 35, 419–425.

Kurtzman, C.P., Fell, J.W. and Boekhout, T. (Eds.) (2011). The Yeasts: A Taxonomic Study, 5th edition, Elsevier, London.

Kurtzman, C.P., Robnett, C.J. and Basehoar-Powers, E. (2001). *Zygosaccharomyces kombuchaensis*, a new ascosporogenous yeast from 'Kombucha tea'. *FEMS Yeast Research,* 1, 133–138.

Kutyauripo, J., Parawira, W., Tinofa, S., Kudita, I. and Ndengu, C. (2009). Investigation of shelf-life extension of sorghum beer (C*hibuku*) by removing the second conversion of malt. *International Journal of Food Microbiology*, 129, 271–276.

Kwon, G.H., Lee, H.A., Park, J.Y., Kim, J.S., Lim, J., Park, C.S., Kwon, D.Y. and Kim, J.H. (2009). Development of a RAPD-PCR method for identification of *Bacillus* species isolated from Cheonggukjang. *International Journal of Food Microbiology*, 129, 282–287.

Lappe-Oliveras, P., Moreno-Terrazas, R., Arrizón-Gaviño, J., Herrera-Suárez, T., Garcia-Mendoza, A. and Gschaedler-Mathis, A. (2008). Yeasts associated with the production of Mexican alcoholic non distilled and distilled Agave beverages. *FEMS Yeast Research* 8, 1037–1052.

Lee, C.H. (1993). Fish fermentation technology in Korea. In: Lee, C.H., Steinkraus K.H. and Alan Reilly P.J. (Eds.) *Fish Fermentation Technology*, United Nations University Press, Tokyo. pp. 187-201.

Lee, C.H. (1997). Lactic acid fermented foods and their benefits in Asia. *Food Control*, 8, 259–269.

Lefeber, T., Janssens, M., Camu, N. and De Vuyst, L. (2010). Kinetic analysis of strains of lactic acid bacteria and acetic acid bacteria in cocoa pulp simulation media toward development of a starter culture for cocoa bean fermentation. *Applied and Environmental Microbiology,* 76, 7708–7716.

Lopetcharat, K., Choi, Y.J., Park, J.W. and Daeschel, M.A. (2001). Fish sauce products and manufacturing: A review. *Food Reviews International*, 17, 65–88.

Lücke, F.-K. (2015). Quality improvement and fermentation control in meat products. In: Holzapfel, W.H. (Ed.), Advances in fermented foods and beverages. Improving quality, technologies and health benefits. Woodhead Publishing Series in Food Science, Technology and Nutrition No. 265. Woodhead Publishing Ltd., Cambridge, pp. 357-376.

Lyumugabe, F., Gros, J., Nzungize, J., Bajyana, E. and Thonart, P. (2012). Characteristics of African traditional beers brewed with sorghum malt: a review. *Biotechnology Agron. Soc. Environment,* 16, 509-530.

Lv, X-C., Huang, X-L., Zhang, W., Rao, P-F. and Ni, L. (2013). Yeast diversity of traditional alcohol fermentation starters for Hong Qu glutinous rice wine brewing, revealed by culture-dependent and culture-independent methods. *Food Control*, 34, 183–190.

Mansi, E.M.T., Bryce, C.F.A. and Hartley, B.S. (2003). Fermentation biotechnology: an historical perspective. In *Fermentation Microbiology and Biotec*hnology, eds. E.L. Mansi and C.F.A. Bryce. New York: Taylor and Francis Group.

Marsh, A.J., O'Sullivan, O., Hill, C.R., Ross, R.P., Cotter, D. 2014. Sequence-based analysis of the bacterial and fungal compositions of multiple kombucha (tea fungus) samples. Food Microbiology 38, 171–178.

Martín, B., Garriga, M., Hugas, M., Bover-Cid, S., Veciana-Noqués, M.T. and Aymerich, T. (2006). Molecular, technological and safety characterization of Gram-positive catalase-positive cocci from slightly fermented sausages. *International Journal of Food Microbiology,* 107, 148–158.

Marty, E., Buchs, J., Eugster-Meier, E., Lacroix, C. and Meile, L. (2011)**.** Identification of staphylococci and dominant lactic acid bacteria in spontaneously fermented Swiss meat products using PCR–RFLP. *Food Microbiology*, 29, 157–166.

Mathara, J.M., Schillinger, U., Kutima, P.M., Mbugua, S.K., Holzapfel, W.H. 2004. Isolation, identification and characterisation of the dominant microorganisms of kule naoto: the Maasai traditional fermented milk in Kenya. International Journal of Food Microbiology 94, 269–278.

Mathara, J.M., Schillinger, U., Kutima, P.M., Mbugua, S.K., Guigas, C., Franz, C., Holzapfel, W.H., 2008a. Functional properties of *Lactobacillus plantarum* strains isolated from Maasai traditional fermented milk products in Kenya. Current Microbiology 56, 315–321.

Mathara, J.M., Schillinger, U., Guigas, C., Franz, C., Kutima, P.M., Mbugua, S.K., Shin, H.K., Holzapfel, W.H. 2008b. Functional characteristics of *Lactobacillus* spp. from traditional Maasai fermented milk products in Kenya. International Journal of Food Microbiology 126, 57–64.

Mayo, B., Ammor, M.S., Delgado, S. and Alegría, A. (2010). Fermented milk products. In: Tamang, J.P., Kailasapathy, K. (Eds.) Fermented Foods and Beverages of the World, CRC Press, Taylor & Francis Group, New York. pp. 263–288.

Meerak, J., Iida, H., Watanabe, Y., Miyashita, M., Sato, H., Nakagawa, Y. and Tahara, Y. (2007). Phylogeny of γ-polyglutamic acid-producing *Bacillus* strains isolated from fermented soybean foods manufactured in Asian countries. *Journal of General and Applied Microbiology*, 53, 315–323.

Meerak, J., Yukphan, P., Miyashita, M., Sato, H., Nakagawa, Y. and Tahara, Y. (2008). Phylogeny of γ-polyglutamic acid-producing *Bacillus* strains isolated from a fermented locust bean product manufactured in West Africa. *Journal of General and Applied Microbiology,* 54, 159–166.

Merican, Z., andYeoh, Q.L. (1989). Tapai proceeding in Malaysia: A technology in transition. In: Steinkraus, K.H. (Ed.). *Industrialization Of Indigenous Fermented Foods*, New York: Marcel Dekker, Inc. pp. 169–189.

Mo, H., Zhu,Y. and Chen, Z. (2008). Microbial fermented tea – a potential source of natural food preservatives. *Trends in Food Science and Technology*, 19, 124–130.

Moreira, N., Mendes, F., Hogg, T., Vasconcelos, I. 2005. Alcohols, esters and heavy sulphur compounds produced by pure and mixed cultures of apiculture wine yeasts. International Journal of Food Microbiology 103, 285–294.

Moroni, A.V., Arendt, E.K., Bello, F.D. 2011. Biodiversity of lactic acid bacteria and yeasts in spontaneously-fermented buckwheat and teff sourdoughs. Food Microbiology 28, 497–502.

Mozzi, F., Eugenia Ortiz, M., Bleckwedel, J., De Vuyst, L., Micaela, P. 2013. Metabolomics as a tool for the comprehensive understanding of fermented and functional foods with lactic acid bacteria. Food Research International 54, 1152–1161.

Mugula, J.K., Ninko, S.A.M., Narvhus, J.A., Sorhaug, T. 2003. Microbiological and fermentation characteristics of *togwa*, a Tanzanian fermented food. International Journal of Food Microbiology 80, 187–199.

Myuanja, C.M.B.K., Narvhus, J.A., Treimo, J., Langsrud, T. 2003. Isolation, characterisation and identification of lactic acid bacteria from bushera: a Ugandan tradition al fermented beverage. International Journal of Food Microbiology 80, 201-210.

Nagai, T., Tamang, J.P. 2010. Fermented soybeans and non-soybeans legume foods.In:Tamang J.P., Kailasapathy, K. (Eds.). Fermented Foods and Beverages of the World, CRC Press, Taylor & Francis Group, New York. pp.191–224.

Nakao, S. 1972. Mame no ryori. In: Ryori no kigen. Tokyo: Japan Broadcast Publishing, Tokyo (Japanese), pp.115–126.

Nam, Y.D., Chang, H.W., Kim, K.H., Roh, S.W., Bae, J.W. 2009. Metatranscriptome analysis of lactic acid bacteria during kimchi fermentation with genome-probing microarrays. International Journal of Food Microbiology 130, 140–146.

Nam, Y.D., Lee, S.Y., Lim, S.I. 2011. Microbial community analysis of Korean soybean pastes bynext-generation sequencing. International Journal of Food Microbiology 155, 36–42.

Nam, Y.D., Yi, S.H., Lim, S.I. 2012. Bacterial diversity of *cheonggukjang*, a traditional Koreanfermented food, analyzed by barcoded pyrosequencing. Food Control 28, 135–142.

Nguyen, H.T, Elegado, F.B., Librojo-Basilio, N.T., Mabesa, R.C., Dozon, E.I. 2011. Isolation and characterisation of selected lactic acid bacteria for improved processing of *Nem chua*, a traditional fermented meat from Vietnam. Beneficial Microbes 1, 67–74.

Nguyen, D.T.L., Van Hoorde, K., Cnockaert, M., de Brandt, E., Aerts, M., Thanh, L.B., Vandamme, P. 2013a. A description of the lactic acid bacteria microbiota associated with the production of traditional fermented vegetables in Vietnam. International Journal of Food Microbiology 163, 19–27.

Nguyen, D.T.L., Van Hoorde, K., Cnockaert, M., de Brandt, E., de Bruyne, K., Le, B.T., Vandamme, P. 2013b. A culture-dependent and -independent approach for the identification of lactic acid bacteria associated with the production of *nem chua*, a Vietnamese fermented meat product. Food Research International 50, 232–240.

Nielsen, D.S., Schillinger, U., Franz, C.M.A.P., Bresciani, J., Amoa-Awua, W., Holzapfel, W.H., Jakobsen, M. 2007. *Lactobacillus ghanensis* sp. nov., a motile lactic acid bacterium isolated from Ghanaian cocoa fermentations. International Journal of Systematic and Evolutionary Microbiology 57, 1468–1472.

Nikkuni, S., Karki ,T.B., Terao,T., Suzuki, C. 1996. Microflora of mana, a Nepalese rice koji. Journal of Fermentation and Bioengineering 81, 168–170.

Nishito, Y., Osana, Y., Hachiya, T., Popendorf, K., Toyoda, A., Fujiyama, A., Itaya, M., Sakakibara, Y. 2010. Whole genome assembly of a natto production strain *Bacillus subtilis natto* from very short read data. BMC Genomics 11, 243–255.

Nout, M.J.R., Aidoo, K.E. 2002. Asian fungal fermented food. In: Osiewacz, H.D. (Ed.). The Mycota, Springer-Verlag, New York, pp. 23–47.

Odunfa, S.A., Oyewole, O.B. 1997. African fermented Foods. Blackie Academic and Professional, London.

Oguntoyinbo, F.A., Dodd, C.E.R. 2010. Bacterial dynamics during the spontaneous fermentation of cassava dough in *gari* production. Food Control 21, 306–312.

Oguntoyinbo, F.A., Sanni Abiodun, I.S., Franz, C.M.A.P., Holzapfel, W.H. 2007. In vitro fermentation studies for selection and evaluation of *Bacillus* strains as starter cultures for the production of okpehe, a traditional African fermented condiment. International Journal of Food Microbiology 113, 208–218.

Oguntoyinbo, F.A., Huch, M., Cho, G.S., Schillinger, U., Holzapfel, W.H., Sanni, A.I., Franz, C.M.A.P. 2010. Diversity of *Bacillus* species isolated from okpehe, a traditional fermented soup condiment from Nigeria. Journal of Food Protection 73, 870–878.

Oguntoyinbo, F.A., Tourlomousi,s P., Gasson, M.J., Narbad, A. 2011. Analysis of bacterial communities of traditional fermented West African cereal foods using culture independent methods. International Journal of Food Microbiology 145, 205–210.

Oki, K., Dugersuren, J., Demberel, S., Watanabe, K. 2014. Pyrosequencing analysis on the microbial diversity in Airag, Khoormog and Tarag, traditional fermented dairy products of Mongolia. Bio Microbiota Food Health 33, 53–64.

Oki, K., Kudo, Y. Watanabe, K. 2012. *Lactobacillus saniviri* sp. nov. and *Lactobacillus senioris* sp. nov., isolated from human faeces. International Journal of Systematic and Evolutionary Microbiology 62, 601–607.

Oki. K., Rai, A.K., Sato, S., Watanabe, K., Tamang, J.P. 2011. Lactic acid bacteria isolated from ethnic preserved meat products of the Western Himalayas. Food Microbiology 28, 1308–1315.

Olasupo, N.A., Odunfa, S.A., Obayori, O.S. 2010. Ethnic African fermented foods, in: Tamang JP, Kailasapathy K. eds. Fermented Foods and Beverages of the World, CRC Press, Taylor & Francis Group, New York. pp. 323–352.

Osvik, R.D., Sperstad, S., Breines, E., Hareide, E., Godfroid, J., Zhou, Z., Ren, P., Geoghegan, C., Holzapfel, W., Ringø, E. 2013. Bacterial diversity of a Masi, a South

African fermented milk product, determined by clone library and denaturing gradient gel electrophoresis analysis. African Journal of Microbiology Research 7, 4146–4158.

Ouoba, L.I., Diawara, B., Wk, A.A., Traore, A., Moller, P. 2004. Genotyping of starter cultures of *Bacillus subtilis* and *Bacillus pumilus* for fermentation of African locust bean (*Parkia biglobosa*) to produce Soumbala. International Journal of Food Microbiology 90, 197–205.

Ouoba, L.I., Kando, C., Parkouda, C., Sawadogo-Lingani, H., Diawara, B., Sutherland, J.P. 2012. The microbiology of Bandji, palm wine of Borassus akeassii from Burkina Faso: identification and genotypic diversity of yeasts, lactic acid and acetic acid bacteria. Journal of Applied Microbiology 113, 1428–1441.

Ouoba, L.I., Nyanga-Koumou, C.A., Parkouda, C., Sawadogo, H., Kobawila, S.C., Keleke, S., Diawara, B., Louembe, D., Sutherland, J.P. 2010. Genotypic diversity of lactic acid bacteria isolated from African traditional alkaline-fermented foods. Journal of Applied Microbiology 108, 2019–2029.

Ouoba, L.I., Parkouda, C., Diawara, B., Scotti, C., Varnam, A. 2008. Identification of *Bacillus* spp. from Bikalga, fermented seeds of *Hibiscus sabdariffa*: phenotypic and genotypic characterization. Journal of Applied Microbiology 104, 122–131.

Oyewole, O.B., Olatunji, O.O., Odunfa, S. A.. 2004. A process technology for conversion of dried cassava chips into ‘gari’. Nigerian Food Journal 22, 65–76.

Papalexandratou, Z., Vrancken, G., De Bruyne, K., Vandamme, P., de Vuyst, L. 2011. Spontaneous organic cocoa bean box fermentations in Brazil are characterized by a restricted species diversity of lactic acid bacteria and acetic acid bacteria. Food Microbiology 28, 1326–1338.

Park, C., Choi, J.C., Choi, Y.H., Nakamura, H., Shimanouchi, K., Horiuchi, T., Misono, H., Sewaki, T., Soda, K., Ashiuchi, M., Sung, M.H. 2005. Synthesis of super-high-molecular-weight poly-γ-glutamic acid by *Bacillus subtilis* subsp. *chungkookjang*. Journal of Molecular Catalysis B: Enzymatic 35, 128–133.

Park, E.J., Chang, H.W., Kim, K.H., Nam, Y.D., Roh, S.W. and Bae, J.W. (2009). Application of quantitative real-time PCR for enumeration of total bacterial, archaeal, and yeast populations in kimchi. *Journal of Microbiology*, 47, 682–685.

Park, E.J., Chun, J., Cha, C.J., Park, W.S., Jeon, C.O. and Bae, J.W. (2012). Bacterial community analysis during fermentation of ten representative kinds of kimchi with barcoded pyrosequencing. *Food Microbiology*, 30, 197–204.

Park, J.M., Shin, J.H., Lee, D.W., Song, J.C., Suh, H.J., Chang, U.J. and Kim, J.M. (2010). Identification of the lactic acid bacteria in kimchi according to initial and over-ripened fermentation using PCR and 16S rRNA gene sequence analysis. *Food Science amd Biotechnology,* 19, 541–546.

Parkouda, C., Nielsen, D.S., Azokpota, P., Ouoba, L.I.I., Amoa-Awua, W.K., Thorsen, L., Houhouigan, J.D., Jensen, J.S., Tano-Debrah, K., Diawara, B. and Jakobsen, M. (2009). The microbiology of alkaline-fermentation of indigenous seeds used as food condiments in Africa and Asia. *Critical Reviews in Microbiology*, 35, 139–156.

Patidar, S.K. and Prajapati, J.B. (1998). Standardization and evaluation of lassi prepared using *Lactobacillus acidophilus* and *Streptococcus thermophilus*. *Journal of Food Science and Technology* 35, 428–431.

Patil, M.M., Pal, A., Anand, T. and Ramana, K.V. 2010. Isolation and characterization of lactic acid bacteria from curd and cucumber. Indian Journal of Biotechnology 9, 166–172.

Picozzi, C., Bonacina, G., Vigentini, I. and Foschino, R. (2010). Genetic diversity in Italian *Lactobacillus sanfranciscensis* strains assessed by multilocus sequence typing and pulsed field gel electrophoresis analyses. *Microbiology*, 156, 2035–2045.

Pederson, C.S. (1979). Microbiology of Food Fermentations, 2nd edition. AVI Publishing Company, Westport.

Phithakpol, B., Varanyanond, W., Reungmaneepaitoon, S. and Wood, H. (1995). The Traditional Fermented Foods of Thailand. ASEAN Food Handling Bureau, Kuala Lumpu.

Plengvidhya, V., Breidt, F. and Fleming, H.P. (2007). Use of RAPD-PCR as a method to follow the progress of starter cultures in sauerkraut fermentation. International Journal of *Food Microbiology*, 93, 287–296.

Pretorius, I.S. (2000). Tailoring wine yeast for the new millennium: novel approaches to the ancient art of winemaking. *Yeast,* 16, 675–729.

Pretorius, I.S., Curtin, C.D., Chambers, P.J. 2015. Designing wine yeast for the future. Chapter 9, In: Holzapfel, W.H. (Ed.), Advances in fermented foods and beverages. Improving quality, technologies and health benefits. Woodhead Publishing Series in Food Science, Technology and Nutrition No. 265. Woodhead Publishing Ltd., Cambridge; ISBN: 978 1 78242 015 6 E-ISBN 978 1 78242 024 8, pp. 197-226.

Puerari, C., Magalhâes-Guedes, T.M., Schwan, R.F. 2015. Physicochemical and microbiological characterization of chicha, a rice-based fermented beverage produced by Umutina Brazilian Amerindians. Food Microbiology 46, 210–217.

Puspito, H., Fleet, G.H. 1985. Microbiology of *sayur asin* fermentation. Applied Microbiology and Biotechnology 22, 442–445.

Qin, H., Yang, H., Qiao, Z., Gao, S., Liu, Z. (2013). Identification and characterization of a *Bacillus subtilis* strain HB-1 isolated from *Yando*u, a fermented soybean food in China. Food Control 31: 22-27.

Quigley, L., O'Sullivan, O., Beresford, T.P., Ross, R.P., Fitzgerald, G.F., Cotter, P.D. 2011. Molecular approaches to analysing the microbial composition of raw milk and raw milk cheese. International Journal of Food Microbiology 150, 81–94.

Rai, A.K., Palni, U. and Tamang, J.P. (2010). Microbiological studies of ethnic meat products of the Eastern Himalayas. *Meat Science*, 85, 560–567.

Ramakrishnan, C.V. 1979. Studies on Indian fermented foods. Baroda Journal of Nutrition 6, 1–54.

Ramos, C.L., de Almeida, E.G., de Melo Pereira, G.V., Cardoso, P.G., Dias, E.S., Schwan, R.F. 2010. Determination of dynamic characteristics of microbiota in a fermented beverage produced by Brazilian Amerindians using culture-dependent and culture-independent methods**.** International Journal of Food Microbiology 140, 225–231**.**

Rani, D.K., Soni, S.K. 2007. Applications and commercial uses of microorganisms. In: Soni, S.K. . (Ed.). *Microbes: a source of energy for 21st century.* Jai Bharat Printing Press, Tohtas Nagar, Shahdara, Delhi. pp. 71–126.

Rhee, S.J., Lee, J.E., Lee, C.H. 2011. Importance of lactic acid bacteria in Asian fermented foods. Microbial Cell Factories 10, 1–13.

Sakai, H., Caldo, G.A., Kozaki, M. 1983.Yeast-flora in red *burong-isda* a fermented fish food from the Philippines. Journal of Agricultural Science (Tokyo), 28, 181–185.

Saisithi, P. 1987. Traditional fermented fish products with special reference to Thai products. ASEAN Food Journal 3, 3–10

Saithong, P., Panthavee ,W., Boonyaratanakornkit, M., Sikkhamondhol, C. 2010. Use of a starter culture of lactic acid bacteria in *plaa-som*, a Thai fermented fish. Journal of Bioscience and Bioengineering 110, 553–557.

Sakamoto, N., Tanaka ,S., Sonomoto, K., Nakayama, J. 2011. 16S rRNA pyrosequencing-based investigation of the bacterial community in nukadoko, a pickling bad of fermented rice bran. International Journal of Food Microbiology 144, 352–359.

Salampessy, J., Kailasapathy, K., Thapa, N. 2010. Fermented fish products. In: Tamang, J.P. and Kailasapathy K. (Eds.). Fermented Foods and Beverages of the World. New York: CRC Press, Taylor & Francis Group, pp. 289–307.

Salminen, S., Wright, A.V., Ouwehand, A. 2004. Lactic Acid Bacteria Microbiology and Functional Aspects, 3rd edition, Marcel Dekker, New York.

Sarkar, P.K., Hasenack, B., Nout, M.J.R. 2002. Diversity and functionality of *Bacillus* and related genera isolated from spontaneously fermented soybeans (Indian Kinema) and locust beans (African Soumbala). International Journal of Food Microbiology 77, 175–186.

Sarkar, P.K., Tamang, J.P. 1994. The influence of process variables and inoculum composition on the sensory quality of kinema. Food Microbiology 11, 317–325.

Sarkar, P.K., Tamang, J.P., Cook, P.E., Owens, J.D. 1994. Kinema-a traditional soybean fermented food: proximate composition and microflora. Food Microbiology 11, 47–55.

Sarkar, S. 2008. Innovations in Indian fermented milk products-a review. Food Biotechnology, 22, 78–97.

Sato, H., Torimura, M., Kitahara, M., Ohkuma, M., Hotta, Y., Tamura, H. 2012. Characterization of the *Lactobacillus casei* group based on the profiling of ribosomal proteins coded in S10-spc-alpha operons as observed by MALDI-TOF MS. Systematic and Appled Microbiology, 35, 447–454.

Savadogo, A., Tapi, A., Chollet, M., Wathelet, B., Traoré, A.S., Jacques, P. 2011. Identification of surfactin producing strains in *Soumbala* and *Bikalga* fermented condiments using Polymerase Chain Reaction and Matrix Assisted Laser Desorption/Ionization-Mass Spectrometry methods. *International Journal of Food Microbiology* 151, 299–306.

Sawadogo-Lingani, H., Lei, V., Diawara, B., Nielsen, D.S., Møller, P.L., Traoré, A.S., Jakobsen, M. 2007. The biodivesity of predominant lactic acid bacteria in dolo and pito wort for the production of sorghum beer. Journal of Applied Microbiology 103, 765-777.

Sawamura, S. 1906. On the micro-organisms of natto. Bulletin College Agri. Tokyo Imperial University 7, 107–110.

Schillinger, U., Ban-Koffi, L., Franz, C.M.A.P. (2010). Tea, coffee and cacao. In: Tamang, J.P., Kailasapathy, K. (Eds). Fermented foods and beverages of the world. 353–375. New York: CRC Press, Taylor & Francis Group.

Schuijt, T.J., Poll, T., de Vos, W.M., Wiersinga, W.J. (2013). Human microbiome: the intestinal microbiota and host immune interactions in the critically ill. *Trends Microbiology,* 21, 221–229.

Sengun, I.Y., Karabiyikli, S. 2011. Importance of acetic acid bacteria in food industry. Food Control 22, 647–665

Sengun, I.Y., Nielsen, D. S., Karapinar, M., Jakobsen, M. 2009. Identification of lactic acid bacteria isolated from Tarhana, a traditional Turkish fermented food. International Journal of Food Microbiology 135, 105–111.

Shamala, T. R., Sreekantiah, K.R. 1988. Microbiological and biochemical studies on traditional Indian palm wine fermentation. Food Microbiology 5, 157–162.

Shin, D.H., Kwon, D.Y., Kim, Y.S., Jeong, D.Y. 2012. Science and Technology of Korean Gochujang. Public Health Edu**,** Seoul.

Shin, M.S., Han, S.K., Ryu, J.S., Kim, K.S., Lee, W.K. 2008. Isolation and partial characterization of a bacteriocin produced by *Pediococcus pentosaceus* K23-2 isolated from kimchi. Journal of Applied Microbiology 105, 331–339.

Shi, Z., Zhang, Y., Phillips, G.O., Yang, G. 2014. Utilization of bacterial cellulose in food**.** Food Hydrocolloids 35, 539–545.

Shon, M.Y., Lee, J., Choi, J.H., Choi, S.Y., Nam, S.H., Seo, K.I., Lee, S.W., Sung, N.J., Park, S.K. 2007. Antioxidant and free radical scavenging activity of methanol extract of chungkukjang. Journal of Food Composition and Analysis 20, 113–118.

Shrestha, H., Nand, K., Rati, E.R. 2002. Microbiological profile of *murcha* starters and physico-chemical characteristics of *poko*, a rice based traditional food products of Nepal. *Food Biotechnology* 16, 1–15.

Singh, D., Singh, J. 2014. Shrikhand: a delicious and healthful traditional Indian fermented dairy dessert. *Trends in* Biosciences 7, 153–155.

Singh, T.A., Devi, K.R., Ahmed, G., Jeyaram, K. 2014. Microbial and endogenous origin of fibrinolytic activity in traditional fermented foods of Northeast India. *Food Research International* 55, 356–362.

Solieri, L., Giudici, P. 2008. Yeasts associated to traditional balsamic vinegar: Ecological and technological features. *International Journal of Food Microbiology*, 125, 36–45.

Sonar, R.N., Halami, P.M. 2014. Phenotypic identification and technological attributes of native lactic acid bacteria present in fermented bamboo shoot products from North-East India. Journal of Food Science and Technology DOI 10.1007/s13197-014-1456-x.

Soni, S. and Dey, G. (2014). Perspectives on global fermented foods. *British Food Journal*, 116, 1767–1787.

Soni, S.K., Sandhu, D.K., Vilkhu, K.S., Kamra, N. (1986). Microbiological studies on Dosa fermentation. Food Microbiology 3, 45–53.

Sridevi, J., Halami, P.M., Vijayendra, S.V.N. 2010. Selection of starter cultures for *idli* batter fermentation and their effect on quality of *idli*. Journal of Food Science and Technology 47, 557–563.

Steinkraus, K.H. 1994. Nutritional significance of fermented foods. Food Research International 27, 259–267.

Steinkraus, K.H. 1996. Handbook of Indigenous Fermented Food, 2nd edition. Marcel Dekker, Inc., New York.

Steinkraus, K.H. 1997. Classification of fermented foods: worldwide review of household fermentation techniques. Food Control 8, 331–317.

Steinkraus, K.H. 2002. Fermentations in world food processing. Comprehensive Reviews in Food Science and Food Safety 1, 23–32.

Steinkraus, K.H., van Veer, A.G., Thiebeau, D.B. 1967. Studies on idli-an Indian fermented black gram-rice food. Food Technology 21, 110–113.

Steinkraus, K.H. (2004). In: Holzapfel, W.H. Talijaard, J.L. (Eds), Industrialization of indigenous fermented foods. Marcel Dekker, Inc, New York, Chapter 7, pp. 363–405.

Stiles, M.E. and Holzapfel, W.H. (1997). Lactic acid bacteria of foods and their current taxonomy. *International Journal of Food Microbiology,* 36, 1–29.

Stevens, H.C., Nabors, L. 2009. Microbial food cultures: a regulatory update. Food Technology (Chicago), 63, 36–41.

Suganuma, T., Fujita, K., Kitahara, K. 2007. Some distinguishable properties between acid-stable and neutral types of α-amylases from acid-producing *koji*. Journal of Bioscience and Bioengineering 104, 353–362.

Sugawara, E. 2010. Fermented soybean pastes *miso* and *shoyu* with reference to aroma, In: Tamang, J.P., Kailasapathy, K. (Eds.) Fermented Foods and Beverages of the World, CRC Press, Taylor & Francis Group, New York, 225–245.

Sujaya, I., Antara, N., Sone, T., Tamura, Y., Aryanta, W., Yokota, A., Asano, K., Tomita, F. 2004. Identification and characterization of yeasts in brem, a traditional Balinese rice wine. World Journal of Microbiology and Biotechnology 20, 143–150.

Sukontasing, S., Tanasupawat, S., Moonmangmee, S., Lee, J.S., Suzuki, K. 2007. *Enterococcus camelliae* sp. nov., isolated from fermented tea leaves in Thailand. International Journal of Systematic and Evolutionary Microbiology 57, 2151–2154.

Sumino, T., Endo, E., Kageyama, A.S., Chihihara, R., Yamada, K. 2003. Various Components and Bacteria of Furu (Soybean Cheese). Journal of Cookery Science of Japan 36, 157–163.

Sun, S.Y., Gong, H.S., Jiang, X.M., Zhao, Y.P. 2014. Selected non-*Saccharomyces* wine yeasts in controlled multistarter fermentations with *Saccharomyces cerevisiae* on alcoholic fermentation behaviour and wine aroma of cherry wines. Food Microbiology 44, 15–23.

Sun, Z., Liu, W., Gao, W., Yang, M., Zhang, J., Wang, J., Menghe, B., Sun, T., Zhang, H. 2010. Identification and characterization of the dominant lactic acid bacteria from *kurut*: the naturally fermented yak milk in Qinghai, China. Journal of General and Applied Microbiology 56, 1–10.

Suprianto Ohba, R., Koga, T., Ueda, S. 1989. Liquefaction of glutinous rice and aroma formation in tapé preparation by ragi. Journal of Fermentation and Bioengineering 64, 249–252.

Takahashi, M., Masaki, K., Mizuno, A., Goto-Yamamoto, N. 2014. Modified COLD-PCR for detection of minor microorganisms in wine samples during the fermentation**.** Food Microbiology, 39, 74–80**.**

Takeda, S., Yamasaki, K., Takeshita, M., Kikuchi, Y., Tsend-Ayush, C., Dashnyam, B., Ahhmed, A.M., Kawahara, S., Muguet ruma, M. 2011. The investigation of probiotic potential of lactic acid bacteria isolated from traditional Mongolian dairy products. Animal Science Journal 82, 571–579.

Tamang, B., Tamang, J.P. 2007. Role of lactic acid bacteria and their functional properties in *Goyang*, a fermented leafy vegetable product of the Sherpas. Journal of Hill Research 20, 53–61.

Tamang, B., Tamang, J.P. 2009. Lactic acid bacteria isolated from indigenous fermented bamboo products of Arunachal Pradesh in India and their functionality. Food Biotechnology 23, 133–147.

Tamang, B., Tamang, J.P. 2010. *In situ* fermentation dynamics during production of *gundruk* and *khalpi*, ethnic fermented vegetables products of the Himalayas. Indian Journal of Microbiology 50 (Suppl 1), 93–98.

Tamang, B., Tamang, J.P., Schillinger, U., Franz, C.M.A.P., Gores, M., Holzapfel, W.H. 2008. Phenotypic and genotypic identification of lactic acid bacteria isolated from ethnic fermented tender bamboo shoots of North East India. International Journal of Food Microbiology 121, 35–40.

Tamang, J.P. 2003. Native microorganisms in fermentation of kinema. Indian Journal of Microbiology 43, 127–130.

Tamang, J.P. 2010a. Himalayan Fermented Foods: Microbiology, Nutrition, and Ethnic Values, CRC Press, Taylor & Francis Group, New York.

Tamang, J.P., 2010b. Diversity of fermented foods, In: Tamang JP, Kailasapathy K. (Eds.) Fermented Foods and Beverages of the World, CRC Press, Taylor & Francis Group, New York, 41–84.

Tamang, J.P. 2010c. Diversity of fermented beverages, In: Tamang J.P., Kailasapathy, K. (Eds.), Fermented Foods and Beverages of the World, CRC Press, Taylor & Francis Group, New York, 85–125.

Tamang, J.P. 2012. Plant-based fermented foods and beverages of Asia. In: *Handbook of Plant-Based Fermented Food and Beverage Technology*, Second Edition (Eds: Hui, Y.H. and Özgül, E.). CRC Press, Taylor & Francis Group, New York, pp. 49–90.

Tamang, J.P. 2014. Biochemical and modern identification techniques - microfloras of fermented foods. In: Batt, C., Tortorello, M.A. (Eds.), *Encyclopaedia of Food Microbiology,* 2 edition Elsevier Ltd., Oxford, pp. 250–258.

Tamang, J.P. (2015a). Health Benefits of Fermented Foods and Beverages. CRC Press, Taylor & Francis Group, New York, pages 636.

Tamang, J.P. (2015b). Naturally fermented ethnic soybean foods of India. *Journal of Ethnic Foods,* 2, 8–17.

Tamang, J.P., Dewan, S., Thapa, S., Olasupo, N.A., Schillinger, U., Wijaya, A. and Holzapfel, W.H. (2000). Identification and enzymatic profiles of predominant lactic acid bacteria isolated from soft-variety *chhurpi*, a traditional cheese typical of the Sikkim Himalayas. *Food Biotechnology,* 14, 99–112.

Tamang, J.P., Dewan, S, Tamang, B., Rai, A., Schillinger, U. and Holzapfel, W.H. (2007). Lactic acid bacteria in *Hamei* and *Marcha* of North East India. *Indian Journal of Microbiology*, 47, 119–125.

Tamang, J.P. and Fleet, G.H. (2009). Yeasts diversity in fermented foods and beverages, In: Satyanarayana, T., Kunze, G. (Eds.), Yeasts Biotechnology: Diversity and Applications, Springer, New York, 169–198.

Tamang, J.P. and Nikkuni, S. (1996). Selection of starter culture for production of kinema, fermented soybean food of the Himalaya. *World Journal of Microbiology and Biotechnology,* 12, 629–635.

Tamang, J.P. and Samuel, D. (2010). Dietary cultures and antiquity of fermented foods and beverages. In: Tamang, J.P., Kailasapathy, K. (Eds.), Fermented Foods and Beverages of the World. CRC press, London, pp. 1–40.

Tamang, J.P. and Sarkar, P.K. (1993). Sinki - a traditional lactic acid fermented radish tap root product. *Journal of General and Applied Microbiology*, 39, 395–408.

Tamang, J.P. and Sarkar, P.K. (1995). Microflora of murcha: an amylolytic fermentation starter. *Microbios,* 81, 115–122.

Tamang, J.P. and Sarkar, P.K. (1996). Microbiology of mesu, a traditional fermented bamboo shoot product. *International Journal of Food Microbiology*, 29, 49–58.

Tamang, J.P., Sarkar, P.K. an Hesseltine, C.W. (1988). Traditional fermented foods and beverages of Darjeeling and Sikkim - a review. *Journal of the Science of Food and Agriculture,* 44, 375–385.

Tamang, J.P., Tamang, B., Schillinger, U., Franz, C.M.A.P., Gores, M. and Holzapfel, W.H. (2005). Identification of predominant lactic acid bacteria isolated from traditional fermented vegetable products of the Eastern Himalayas. *International Journal of Food Microbiology,* 105, 347–356.

Tamang, J.P., Tamang, B., Schillinger, U., Guigas, C. and Holzapfel, W.H. (2009). Functional properties of lactic acid bacteria isolated from ethnic fermented vegetables of the Himalayas. *International Journal of Food Microbiology*, 135, 28–33.

Tamang, J.P., Tamang, N., Thapa, S., Dewan, S., Tamang, B.M., Yonzan, H., Rai, A.K., Chettri, R., Chakrabarty, J. and Kharel, N. (2012). Microorganisms and nutritional value of ethnic fermented foods and alcoholic beverages of North East India. *Indian Journal of Traditional Knowldege*, 11, 7–25.

Tamang, J.P., Thapa, S., Tamang, N. and Rai, B. (1996). Indigenous fermented food beverages of Darjeeling hills and Sikkim: process and product characterization. *Journal of Hill Research,* 9, 401-411.

Tamang, J.P., Thapa, S., Dewan, S., Jojima, Y., Fudou, R. and Yamanaka, S. (2002). Phylogenetic analysis of *Bacillus* strains isolated from fermented soybean foods of Asia: *Kinema, chungkokjang* and *natto*. *Journal of Hill Research*, 15, 56–62.

Tamang, J.P. and Thapa, S. (2006). Fermentation dynamics during production of bhaati jaanr, a traditional fermented rice beverage of the Eastern Himalayas. *Food Biotechnology*, 20, 251–261.

Tamime, A.Y. and Robinson, R.K. (2007). Yoghurt Science and Technology. Woodhead Publishing Ltd., Cambridge.

Tanasupawat, S., Pakdeeto, A., Thawai, C., Yukphan, P. and Okada, S. (2007). Identification of lactic acid bacteria from fermented tea leaves (miang) in Thailand and proposals of *Lactobacillus thailandensis* sp. nov., *Lactobacillus camelliae*sp. nov., and *Pediococcus siamensis* sp. nov. *Journal of General and Applied Microbiology*, 53, 7–15.

Tanigawa, K., Kawabata, H. and Watanabe, K. (2010). Identification and typing of *Lactococcus lactis* by matrix-assisted laser desorption ionization – time-of-flight mass spectrometry. *Applied and Environmental Microbiology*, 76, 4055–4062.

Tanigawa, K. and Watanabe, K. (2011). Multilocus sequence typing reveals a novel subspeciation of *Lactobacillus delbrueckii*. *Microbiology,* 157, 727–738.

Taylor, J.R.N. (2003). Beverages from sorghum and millet, In: Caballero B, Trugo LC, Finglas PM. (Eds.) Encyclopedia of Food Sciences and Nutrition, 2nd edition, Academic Press, London, pp. 2352–2359.

Teoh, A.L., Heard, G. and Cox, J. (2004). Yeasts ecology of Kombucha fermentation. *International Journal of Food Microbiology,* 95, 119–126.

Thanh, V.N., Mai, L.T. and Tuan, D. A. (2008). Microbial diversity of traditional Vietnamese alcohol fermentation starters (*banh men*) as determined by PCR-mediated DGGE. *International Journal of Food Microbiology*, 128, 268–273.

Thapa, N., Pal, J. and Tamang, J.P. (2004). Microbial diversity in ngari, hentak and tungtap, fermented fish products of Northeast India. *World Journal of Microbiology and Biotechnology,* 20, 599–607.

Thapa, N., Pal, J. and Tamang, J.P. (2006). Phenotypic identification and technological properties of lactic acid bacteria isolated from traditionally processed fish products of the Eastern Himalayas. *International Journal of Food Microbiology*, 107, 33–38.

Thapa, N., Pal, J., Tamang, J.P. 2007. Microbiological profile of dried fish products of Assam, Indian Journal of Fisheries 54, 121–125.

Thapa, S., Tamang, J.P. 2004. Product characterization of kodo ko jaanr: fermented finger millet beverage of the Himalayas. Food Microbiology 21, 617–622.

Thapa, S., Tamang, J.P. 2006. Microbiological and physico-chemical changes during fermentation of kodo ko jaanr, a traditional alcoholic beverage of the Darjeeling hills and Sikkim. Indian Journal of Microbiology 46, 333–341.

Tou, E.H., Mouquet-River, C., Rochette, I., Traoré, A.S., Treche, S., Guyot, J.P. 2007. Effect of different process combinations on the fermentation kinetics, microflora and energy density of *ben-saalga*, a fermented gruel from Burkina Faso. Food Chemistry 100, 935–943.

Tsuyoshi, N., Fudou, R., Yamanaka, S., Kozaki, M., Tamang, N., Thapa, S., Tamang, J.P. 2005. Identification of yeast strains isolated from marcha in Sikkim, a microbial starter for amylolytic fermentation. International Journal of Food Microbiology 99, 135–146.

Urushibata, Y., Tokuyama, S., Tahara, Y. 2002. Characterization of the *Bacillus subtilisyws C* gene, involved in λ–polyglutamic acid production. Journal of Bacteriology 184, 337–343.

van Hijum, S.A.F.T., Vaughan, E.E., Vogel, R.F. 2013. Application of state-of-art sequencing technologies to indigenous food fermentations. Current Opinion in Biotechnology 24, 178–186.

Vallejo, J.A., Miranda, P., Flores-Félix, J.D., Sánchez-Juanes, F., Ageitos, J.M., González-Buitrago, J.M., Velázquez, E., Villa, T.G. 2013. Atypical yeasts identified as *Saccharomyces cerevisiae* by MALDI-TOF MS and gene sequencing are the main responsible of fermentation of *chicha*, a traditional beverage from Peru**.** Systematic and Applied Microbiology 36, 560–564.

Vieira-Dalodé. G., Jespersen, L., Hounhouigan, J., Moller, P.L., Nago, C.M., Jakobsen, M. 2007. Lactic acid bacteria and yeasts associated with *gowé* production from sorghum in Bénin. Journal of Applied Microbiology 103, 342–349.

Walker, G.M. 2014. Microbiology of Winemaking. In: Batt, C. and Tortorello, M.A. (Eds). Encyclopaedia of Food Microbiology, 2dition Elsevier Ltd., Oxford, pp. 787–792.

Wang, J., Fung, D.Y.C. 1996. Alkaline-fermented foods: A review with emphasis on pidan fermentation. Critical Review of Microbiology 22, 101–138.

Wang, C.T., Ji, B.P., Li, B., Nout, R., Li, P.L., Ji, H. and Chen, L.F. (2006). Purification and characterization of a fibrinolytic enzyme of *Bacillus subtilis* DC33, isolated from Chinese traditional *Douchi*. *Industrial Microbiology and Biotechnology,* 33, 750–758.

Wang, J., Tang, H., Zhang, C., Zhao, Y., Derrien, M., Rocher, E., Van Hylckama Vlieg, J.E.T., Strissel, K., Zhao, L., Obin, M., Shen, J. 2015. Modulation of gut microbiota during probiotic-mediated attenuation of metabolic syndrome in high fat diet-fed mice. The ISME Journal 9, 1-15.

Watanabe, K., Fujimoto, J., Sasamoto, M., Dugersuren, J., Tumursuh, T., Demberel, S. (2008). Diversity of lactic acid bacteria and yeasts in airag and tarag, traditional fermented milk products from Mongolia. *World Journal of Microbiology and Biotechnology,* 24, 1313–1325.

Watanabe, K., Fujimoto, J., Tomii, Y., Sasamoto, M., Makino, H., Kudo, Y., Okada, S. (2009a). *Lactobacillus kisonensis* sp. nov., *Lactobacillus otakiensis* sp. nov., *Lactobacillus* rapi sp. nov. and *Lactobacillus sunkii* sp. nov., heterofermentative species isolated from sunki, a traditional Japanese pickle. *International Journal of Systematic and Evolutionary Microbiology*, 59, 754–760.

Watanabe, K., Makino, H., Sasamoto, M., Kudo, Y., Fujimoto, J., Demberel, S. (2009b). *Bifidobacterium mongoliense* sp. nov., from *airag*, a traditional fermented mare's milk product from Mongolia. *International Journal of Systematic and Evolutionary Microbiology* ,59, 1535–1540.

Weckx, S., Meulen, van der., Maes, R., Scheirlinck, D., Huys, I., Vandamme, G.P., De Vuyst, L. (2010). Lactic acid bacteria community dynamics and metabolite production of rye sourdough fermentations share characteristics of wheat and spelt sourdough fermentations. *Food Microbiology*, 27, 1000–1008.

Wei, D., Jong, S. 1983. Chinese rice pudding fermentation: fungal flora of starter cultures and biochemical changes during fermentation. Journal of Fermentation Technology 61, 573–579.

Winarno, F.G. 1986. Traditional technologies of Indonesia with special attention to fermented foods. In: Traditional foods: some products and technologies, CFTRI, Mysore, pp. 136–147.

Wood, B.J. B. 1998. Microbiology of fermented foods. Blackie Academic Professional, London.

Wongputtisin, P., Khanongnuch, C., Kongbuntad, W., Niamsup, P., Lumyong, S., Sarkar, P.K. 2014. Use of *Bacillus subtilis* isolates from Tua-nao towards nutritional improvement of soya bean hull for monogastric feed application. Letters in Applied Microbiology 59, 328–333.

Wu, Y.C., Kimura, B., Fujii, T. (2000). Comparison of three culture methods for the identification of *Micrococcus* and *Staphylococcus* in fermented squid shiokara. *Fisheries Science,* 66, 142–146.

Wu, R., Wang, L., Wang, J., Li, H., Menghe, B., Wu, J., Guo, M., Zhang, H. (2009). Isolation and preliminary probiotic selection of lactobacilli from Koumiss in Inner Mongolia. *Journal of Basic Microbiology*, 49, 318–326.

Yamamoto, S., Matsumoto, T. (2011). Rice fermentation starters in Cambodia: cultural importance and traditional methods of production. *Southeast Asian Studies,* 49, 192–213.

Yan, P.M., Xue, W.T., Tan, S.S., Zhang, H., Chang, X.H. (2008). Effect of inoculating lactic acid bacteria starter cultures on the nitrite concentration of fermenting Chinese paocai. *Food Control*, 19, 50–55.

Yan, Y., Qian, Y., Ji, F., Chen, J., Han, B. 2013. Microbial composition during Chinese soy sauce *koji*-making based on culture dependent and independent methods**.** Food Microbiology 34, 189–195.

Yonzan, H., Tamang, J.P. 2010. Microbiology and nutritional value of *selroti*, an ethnic fermented cereal food of the Himalayas. Food Biotechnology 2, 227–247.

Yonzan, H., Tamang, J.P. 2013. Optimization of traditional processing of *Selroti*, a popular cereal-based fermented food. Journal of Scientific and Industrial Research 72, 43–47.

Yoon, M.Y., Kim, Y.J., Hwang, H.J. 2008. Properties and safety aspects of *Enterococcus faecium* strains isolated from *Chungkukjang*, a fermented soy product. LWT- Food Science and Technology 41, 925–933.

Yousif, N.M.K., Huch, M., Schuster, T., Cho, G.S., Dirar, H.A., Holzapfel, W.H. and Franz, C.M.A.P. (2010). Diversity of lactic acid bacteria from Hussuwa, a traditional African fermented sorghum food. *Food Microbiology*, 27, 757–68.

Yu, J., Wang, W.H., Menghe, B.L., Jiri, M.T., Wang, H.M., Liu, W.J., Bao, Q.H., Zhang, J.C., Wang, F., Xu, H.Y., Sun, T.S. and Zhang, H.P. (2011). Diversity of lactic acid bacteria associated with traditional fermented dairy products in Mongolia. *Journal of Dairy Science,* 94, 3229–3241.

Zhang, J.H., Tatsumi, E., Fan, J.F., Li, L.T. (2007). Chemical components of *Aspergillus*-type Douchi, a Chinese traditional fermented soybean product, change during the fermentation process. *International Journal of Food Science and Technology,* 42, 263–268.

Zhu, Y.P., Cheng, Y.Q., Wang, L.J., Fan, J.F., Li, L.T. (2008). Enhanced antioxidative activity of Chinese traditionally fermented Okara (Meitauza) prepared with various microorganism. *International Journal of Food Properties*, 11, 519–529.

Zhu, Y. and Trampe, J. (2013). Koji – where East meets West in fermentation**.** *Biotechnology Advance,* 31, 1448–1457.