

Jyoti Prakash Tamang *Editor*

# Ethnic Fermented Foods and Alcoholic Beverages of Asia

 Springer

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## Preface

Asia has a long history of preparation and consumption of various types of ethnic fermented foods and alcoholic beverages based on available raw substrates of plant or animal sources and also depending on agroclimatic conditions of the regions. About 90% of the Asian ethnic fermented foods are naturally fermented by both culturable and unculturable microorganisms. Diversity of functional microorganisms in Asian ethnic fermented foods and alcoholic beverages consists of bacteria (lactic acid bacteria and *Bacillus* species, micrococci, etc.), amylolytic and alcohol-producing yeasts, and filamentous molds. Microorganisms establish on relevant substrates for survival and produce bioactive compounds that enrich the human diet, thereby promoting health benefits to consumers.

This book has 15 chapters covering different types of ethnic fermented foods and alcoholic beverages of Asia. I tried to cover all Asian countries for this book, but could not get contributors for book chapters from many countries. However, I am grateful to all contributing authors who accepted our invitation to write this book. Some of them are well-known scientists and researchers with vast experiences in the field of fermented foods and beverages. We are happy to bring all of them in the same platform, bringing out this book, and thanks to Prof. Tek Chand Bhalla, Dr. Namrata Thapa, and Dr. Savitri (India); Prof. Yearul Kabir and Dr. Mahmud Hossain (Bangladesh); Prof. Tika Karki, Dr. Pravin Ojha, and Dr. Om Prakash Panta (Nepal); Dr. Saeed Akhtar, Dr. Majid Hussain, Dr. Tariq Ismail, and Dr. Muhammad Riaz (Pakistan); Prof. Sagarika Ekanayake (Sri Lanka); Dr. Werasit Sanpamongkolchai (Thailand); Prof. Sh.Demberel, Dr. D. Narmandakh, and Dr. N. Davaatseren (Mongolia); Dr. Yoshiaki Kitamura, Dr. Ken-Ichi Kusumoto, Dr. Yukio Magariyama, Dr. Tetsuya Oguma, Dr. Toshiro Nagai, Dr. Soichi Furukawa, Dr. Chise Suzuki, Dr. Masataka Satomi, Dr. Kazunori Takamine, Dr. Hisanori Tamaki, and Dr. Sota Yamamoto (Japan); Prof. Dong-Hwa Shin, Prof. Cherl-Ho Lee, Dr. Young-Myoung Kim, Dr. Wan-Soo Park, Dr. Jae-Ho Kim, and Dr. Moon-sil Lee Kim (South Korea); Dr. Maryam Tajabadi Ebrahimi, Dr. Neda Mollakhalili Meybodi, and Dr. Amir Mohammad Mortazavian (Iran); Dr. Francisco B. Elegado, Dr. Maria Teresa M. Perez, Dr. Shara Mae T. Colegio, Dr. Charina Grace B. Banaay, Dr. Bernadette C. Mendoza, Dr. Vanessa Marie T. Lim, Dr. Andrea Therese R. Gervasio, and Dr. Marilen P. Balolong (Philippines); Prof. Ingrid Suryanti Surono (Indonesia); and Dr. Vu Nguyen Thanh and Dr. Nguyen Thi Viet Anh (Vietnam). We are also grateful to Springer for bringing out this comprehensive

book on important topics. We hope this book will be read by researchers, students, teachers, nutritionists, dieticians, food entrepreneurs, agriculturalist, government policy makers, ethnologists, sociologists, and electronic media persons who keep interest on the health benefits of fermented foods and beverages. Though there are hundreds of research articles, review papers, and limited books on fermented foods and beverages, this book *Ethnic Fermented Foods and Alcoholic Beverages of Asia* is the first of this kind on compilation of various ethnic fermented foods and alcoholic beverages of Asia.

I dedicate this book to Asian ethnic people who invented their indigenous knowledge of traditional food fermentation technology and have created a platform for research to study in depth molecular microbiology, nutrition, and bioactive compounds in ethnic fermented foods and beverages.

Gangtok, India

Jyoti Prakash Tamang

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## Contents

<b>1</b>	<b>History of Fermented Foods in Northeast Asia</b> .....	<b>1</b>
	Cherl-Ho Lee and Moonsil Lee Kim	
<b>2</b>	<b>Ethnic Fermented Foods and Beverages of India</b> .....	<b>17</b>
	Jyoti Prakash Tamang, Namrata Thapa, Tek Chand Bhalla, and Savitri	
<b>3</b>	<b>Ethnic Fermented Foods and Beverages of Bangladesh</b> .....	<b>73</b>
	Mahmud Hossain and Yearul Kabir	
<b>4</b>	<b>Ethnic Fermented Foods of Nepal</b> .....	<b>91</b>
	Tika Karki, Pravin Ojha, and Om Prakash Panta	
<b>5</b>	<b>Ethnic Fermented Foods of Pakistan</b> .....	<b>119</b>
	Saeed Akhtar, Majid Hussain, Tariq Ismail, and Muhammad Riaz	
<b>6</b>	<b>Ethnic Fermented Foods and Beverages of Sri Lanka</b> .....	<b>139</b>
	Sagarika Ekanayake	
<b>7</b>	<b>Ethnic Fermented Foods and Beverages of Thailand</b> .....	<b>151</b>
	Werasit Sanpamongkolchai	
<b>8</b>	<b>Ethnic Fermented Foods and Beverages of Mongolia</b> .....	<b>165</b>
	Sh. Demberel, D. Narmandakh, and N. Davaatseren	
<b>9</b>	<b>Ethnic Fermented Foods and Alcoholic Beverages of Japan</b> ....	<b>193</b>
	Yoshiaki Kitamura, Ken-Ichi Kusumoto, Tetsuya Oguma, Toshiro Nagai, Soichi Furukawa, Chise Suzuki, Masataka Satomi, Yukio Magariyama, Kazunori Takamine, and Hisanori Tamaki	
<b>10</b>	<b>Ethnic Fermented Foods and Beverages of Cambodia</b> .....	<b>237</b>
	Sota Yamamoto	
<b>11</b>	<b>Ethnic Fermented Foods and Beverages of Korea</b> .....	<b>263</b>
	Dong-Hwa Shin, Young-Myoung Kim, Wan-Soo Park, and Jae-Ho Kim	
<b>12</b>	<b>Ethnic Fermented Foods and Beverage of Iran</b> .....	<b>309</b>
	Neda Mollakhalili Meybodi, Maryam Tajabadi Ebrahimi, and Amir Mohammad Mortazavian	

**13 Ethnic Fermented Foods of the Philippines with Reference to Lactic Acid Bacteria and Yeasts** ..... 323  
Francisco B. Elegado, Shara Mae T. Colegio,  
Vanessa Marie T. Lim, Andrea Therese R. Gervasio,  
Maria Teresa M. Perez, Marilen P. Balolong,  
Charina Grace B. Banaay, and Bernadette C. Mendoza

**14 Ethnic Fermented Foods and Beverages of Indonesia** ..... 341  
Ingrid Suryanti Surono

**15 Ethnic Fermented Foods and Beverages of Vietnam** ..... 383  
Vu Nguyen Thanh and Nguyen Thi Viet Anh

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## Author Biography of Professor Jyoti Prakash Tamang

Professor Dr. **Jyoti Prakash Tamang** is one of the authorities of global fermented foods and beverages for the last 28 years. He did his Ph.D. in microbiology at North Bengal University, India, in 1992, and postdoc research works at the National Food Research Institute, Tsukuba, Japan, in 1995, and Institute of Hygiene and Toxicology, Germany, in 2002. He was given the prestigious National Bioscience Award of the Department of Biotechnology by the Government of India in 2005 and Gourmand Best Cookbook Award of Paris in 2010. He is a Fellow of National Academy of Agricultural Sciences (2012), Fellow of Indian Academy of Microbiological Sciences (2010), and Fellow of Biotech Research Society of India (2006). He has published more than 135 research papers and authored several books including (1) *Himalayan Fermented Foods: Microbiology, Nutrition, and Ethnic Values* (2010), (2) *Fermented Foods and Beverages of the World* (2011), and (3) *Health Benefits of Fermented Foods and Beverages* (2015) all published by CRC Press, Taylor & Francis Group, USA. He has one patent and has produced several Ph.D. students. He is a member of several prestigious national and international academics including the International Yeast Commission, Asian Federation of Lactic Acid Bacteria, etc. Prof. Tamang is a professor in the Department of Microbiology and also dean of the School of Life Sciences at Sikkim University, a national university at Gangtok.

Cherl-Ho Lee and Moonsil Lee Kim

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## 1.1 Introduction: Where and Who?

Northeast Asian culture has been generally considered as part of Chinese civilization because currently a large portion of this region is occupied by the People's Republic of China (PRC), and the relatively small nations around the PRC have been simply understood as strongly influenced by Chinese civilization in terms of politics, economy, and culture. However, Northeast Asian culture is composed of many different ethnic groups that have developed their own identities and distinctive cultures throughout history. Therefore, before starting a discussion on the fermented food in Northeast Asia, it should be clarified where and about whom we are talking in this chapter.

The definition of Northeast Asia varies according to the context in which it is discussed. From an economic view, it indicates China, South Korea, and Japan, as these nations are dominating current economic growth in the region. In terms of the regional security of Northeast Asia,

North Korea is at the center of this issue in relation to the surrounding countries of South Korea, China, Japan, and Russia. Sometimes people use the term “Northeast Asia” to indicate much broader territories including Mongolia, Taiwan, and eastern regions of the Russian Federation and Siberia. In this chapter on the fermented foods of Northeast Asia, we define Northeast Asia as the northeastern subregion of Asia that includes the Korean Peninsula, the Japanese archipelago, Manchuria, the Russian Far East, and the Chinese northeast coast, along with the Bohai Sea and the Yellow Sea (Map 1.1). In particular, the fermented food culture and technologies developed in the Korean Peninsula and the surrounding area of the Korea Strait will be the focus of discussion in this chapter.

The people who occupied Northeast Asia were first introduced in the Chinese history book, *Hou Hanshu (History of the Later Han Dynasty)* in the fifth century AD, as “eastern archers (*dongyi* 東夷),” collectively referring to several ethnic groups and tribes in Northeast Asia (Ban, fifth century). This Chinese word “*dongyi*” has been traditionally translated as “eastern barbarians” from the Sino-centric perspective, but here we suggest interpreting this word as “eastern archers” since the character “*yi* 夷” was originally composed of a combination of two words, “big (大)” and “bow (弓).” The mural painting of the Koguryō (ca. 37 BC–668 AD) tomb of Muyongchong in Manchuria that depicted horse

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**Map 1.1** Northeast Asia

riders with big bows supports the possibility that the Dongyi were people who had good archery skills, as the name indicates. The *History of the Later Han Dynasty* describes Dongyi people who were good at horse riding and archery and who established several proto-states in Manchuria, the Korean Peninsula, and the Japanese archipelago, such as Puyō, Dongye, Okchō, Koguryō, Samhan, and Wa. This indicates that as early as the third century BC, the Dongyi had already formed a unique culture that differed from the well-known Chinese civilization that had thrived in Central and Southern China. However, it was much earlier that Chinese people recognized these archers (*yi*) as non-Chinese, as we can see from the oracle bone inscription of the Shang period (1600–1046 BC) in China, dating to around 1200–1046 BC, that reads “...the king orders to campaign against the Yi” (Ebrey 1993).

This historical evidence implies that several ethnic groups called Dongyi who had occupied Northeast Asia and competed with Chinese people since around 1000 BC or earlier must have had stable food resources that sustained the people and their communities during famines. Historical and archaeological remains tell us that the fermented foods they enjoyed, such as fermented fish, fermented vegetables, and fermented soybean products, were the most reliable and stable sources for obtaining protein throughout the year. The dietary culture of the Dongyi people, based on various fermented foods, was the result of the early use of fermentation technology, which originated in this region. In this chapter, before an in-depth scientific analysis of traditional fermented foods in Northeast Asia, the birth and the development of the fermentation technology of the Dongyi will be discussed. In

particular, the geographical and environmental background and the primitive pottery culture will be examined as prerequisites of the birth of fermentation technology in Northeast Asia.

## 1.2 Pottery and Dietary Culture of Northeast Asia

The trace of earlier people in this region can be found in archaeological discoveries. Archaeological remains suggest that this region was occupied by Early Paleolithic people who immigrated through Mainland China, Siberia, or South Asia as early as the Early Pleistocene period (~1,600,000 BP, Bae 2010). The early existence of human beings in this region is evidenced by some Early Paleolithic remains (1,800,000–300,000 BP) of the Early/Middle Pleistocene period on the northeast Chinese mainland and Korean Peninsula. Several Early Paleolithic sites, such as the Zhoukoudian (of Peking man, dated 680,000–780,000 years old) and Jinniushan sites, have been excavated in Northeast China and Manchuria. The earliest hominin fossils in the Korean Peninsula excavated from central South Korea (Chǒngokni) and in Pyǒngyang (Daehyǒndong) have been dated to the early Middle Paleolithic sites (350,000–40,000 BP), but lithic assemblage was discovered in Komunmoru, Jangsanni, and Jangdongni that seem older than Chǒngokni (Bae 2010). In addition, Middle Paleolithic remains were found on the Korean Peninsula and in South Manchuria, and numerous Late Paleolithic (40,000–10,000 BP) sites were also found on the Korean Peninsula, South Manchuria, and Japanese archipelago. These sites indicate an increase in population and a dispersal of people in this region of Northeast Asia during the Paleolithic period.

Paleolithic hominin survived by mobile hunting and mountain foraging. They preyed on deer, wild pig, bison, and roe. These animals provided people with meat, gut, and blood. Animal meat, intestine, and blood were probably the main foodstuff for these people, with the use of vegetable supplements, such as grass seeds, tree nuts,

and wild fruits and roots. Those who reached the Korean Peninsula gradually adapted themselves to their new environment as they changed dwelling site and diet habits. The meat-centered diet culture of the early hominin in Northeast Asia gradually changed to an omnivorous culture by the end of the Paleolithic Age. According to archaeological remains from the Korean Peninsula, peoples there increasingly consumed tree nuts and acorns, wild fruits, berries and grapes, grass seeds, roots, and young buds of trees and ferns. The appearance of the pollen of grass, rice (Gramineae), and beans (Leguminosae, Papilionoideae) also increased in Late Paleolithic remains (Lee 1998).

Paleolithic hominin of Northeast Asia who lived in mountain caves at the beginning gradually moved to the lower plains and riverbanks by the Late Paleolithic Age (Lee 1998). As they could now obtain abundant food around their dwelling sites, they could stay longer in these areas. Beginning to inhabit one single place, they reduced their mobile hunting practices and instead obtained more food by collecting seeds of grass and barnyard grass, millet, and wild beans. Gradually they developed skills in storing food resources by drying. Step by step, they became accustomed to collecting mollusks like frogs and snails in damp ground and clams and shellfish in rivers and beaches.

As they transferred dwelling site from the hill and cave to the coastline and riverside, ancient Northeast Asians experienced yet another significant change in their dietary culture. They began increasingly to consume marine products while also still enjoying tree nuts, acorns, wild grains, fruits, vegetables, and roots. Archaeological evidence such as numerous shell mounds along the coastal line of the Korean Peninsula and the Japanese archipelago clearly proves that the dietary habit of the people changed at the beginning of the Holocene period (ca. 10,000 BC) as their dwelling sites moved to the coastline (Lee 2001).

Interestingly, the increased consumption of marine products coincided with the invention of primitive pottery. Around the Late Paleolithic Age, by 6000 BC, the use of *Jeulmun* (Korean) or

*Jomon* (Japanese) pottery had spread over the region of the Korean Peninsula and the Japanese archipelago. Archaeologists call this period the *Jeulmun* period in the Korean Peninsula and the *Jomon* period in the Japanese archipelago (from ca. 8000 BC). This period is comparable to the western Neolithic period, although people in Northeast Asia had not started agriculture yet at this point. Western archaeology distinguishes the Neolithic Age from the Paleolithic by the use of polished stone tools and the start of agriculture, since these two events appear to have taken place at the same period around 8000 BC in Europe. However, this chronicle is unsuitable to that of Northeast Asia, where there are indications of the use of ground stone tools some 30,000 years old, and primitive earthenware of 12,000 years old has been discovered, while the oldest evidence of agriculture is only ca. 5000 years old (Barnes 1993). Therefore, we suggest referring to this period from the birth of earthenware to the beginning of agriculture in Northeast Asia as the “Primitive Pottery Age” in order to distinguish it from the European Mesolithic culture (Lee 1999).

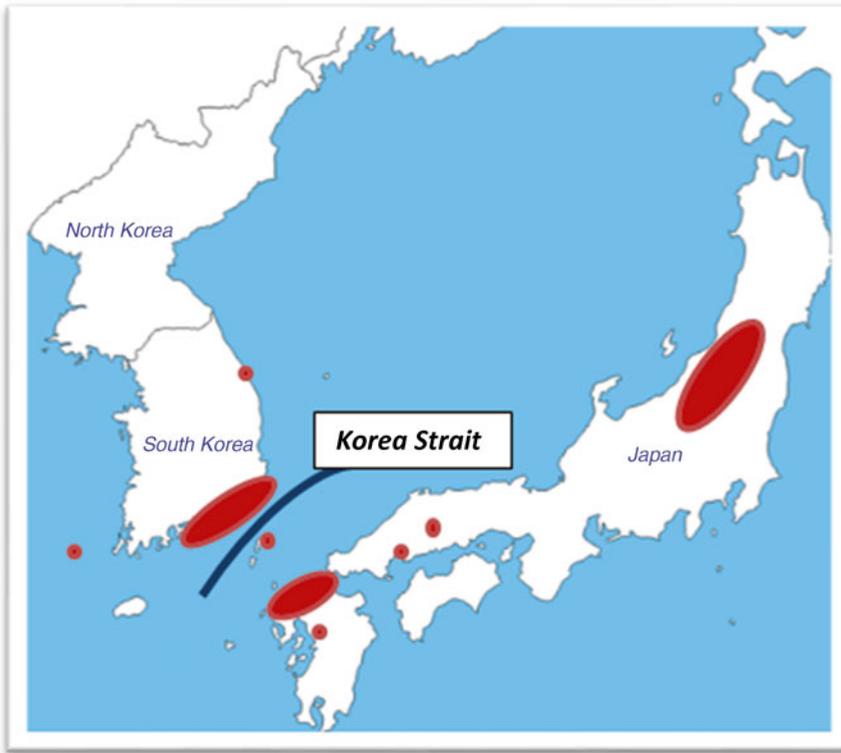
The Korean Peninsula functioned as a land bridge connecting the seasonal movements of Paleolithic hunters from the north of Manchuria to the south of the Japanese archipelago, with the Korea Strait as an obstacle obstructing their journey. Consequently, people gathered around the coastal region of the Korea Strait, making it the cultural center for the creation of the Primitive Pottery Age (Lee 1999). It is supported by the fact that the early Primitive Pottery Age remains are located in the Korean Peninsula (Dongsamdong, Dadaepo, Chilgok, Sangnodaedo, Yokjido, Sohuksando, Osanri) and the Japanese archipelago (Kosijima, Nishikaratsu, Iwasita, Senpukuji, Todoroki, Kamikuroiwa, Mawatari, Yagimata, Isigoya, Hasitate, Tazawa, Ozawa) (Han 1983). In particular, many remains have been found around Korea Strait coastal areas including the southeast portion of the Korean Peninsula and northwest of Kyushu Island (Map 1.2).

The use of earthenware itself may have been enough to create a revolutionary impact that dramatically changed the production and processing

of food in the Korea Strait region between 6000 and 3000 BC, prior to the period of Neolithic agricultural settlements. The marine foods obtained from the coastal regions and riversides were difficult to dry, easily decomposed by autolysis, and rapidly spoiled by microbial growth, so people needed to consume them instantly, and therefore they were not likely to rely much on marine food. However, the invention of earthenware enabled them to cook perishable foods easily and store them longer for eating. This cultural trend of seafood consumption preceding farm products still remains today: Koreans and Japanese are the only people in the world who consume seaweed and laver as daily food and eat more fish and shellfish than meat.

Moreover, earthenware was used for cooking fish and vegetables in seawater (Lee 1999). Before man knew the salty taste from marine foods, people used to take minerals (salt) from either animal blood or intestine. People alive during the *Jeulmun* and *Jomon* periods possibly enjoyed cooking seafood with vegetables, roots, and grains with seawater in an earthen vessel as they came to understand that the salty taste enabled them to eat more vegetables and plants, which enabled them to survive on plants when game was scant. Using pottery and seawater to cook marine food resources and vegetables can be related to the origin of “hot pot culture,” the so-called *chigae* culture in Korea and *nabe* culture in Japan, which are the most characteristic Northeast Asian foods today. This culture is similar to that of the primitive people living in the coastal region of Papua New Guinea today who still use seawater as a salty ingredient for cooking (Ishige 1976).

In about 3000–2000 BC, which is referred to as the Late Neolithic Age by Korean archaeologists, polished stone tools were replaced by chopped stone tools, and in using these new tools, farming agriculture began. This period is actually a Neolithic Age according to the European standard since it marks the start of agricultural farming. Tribes based around agriculture and fishery settlements emerged in Northeast Asia during this period. This Neolithic period was followed by the Bronze Age in the Korean Peninsula



**Map. 1.2** Locations of the early Primitive Pottery Age remain in the coastal region of Korea Strait

around 1200 BC when the megalithic culture represented by dolmens and menhirs developed.

Earthenware played another significant role in the birth of a new dietary culture in Northeast Asia during the Bronze Age: that of using soybeans in this region. When the horse-riding people of the north, the *Yemaek* tribe of Northeastern Dongyi, came to the south of the Korean Peninsula and became agricultural farming settlers, they began to use wild soybeans as a stable protein source to replace meat from their animal herds. It has been proposed that the *Maek* tribes, who settled broadly in Manchuria and the Korean Peninsula, are the first users of soybeans for food in history (Lee 1984). Chinese history books and literature also indicate that soybean cultivation was concentrated in the region of Northeast Asia, in particular, Manchuria and the Korean Peninsula, since the Bronze Age (Choi 2009). As they began relying on soybeans, the people of Northeast Asia invented and developed the process of making soybeans into food by soaking

them in water and cooking them in earthen vessels to eliminate the anti-nutritional factors in the bean. An earthen vessel excavated from Paldang in Korea, which has traces of soybeans on the surface, supports the theory that these peoples used pottery for cooking soybeans in Central Korea beginning in the Bronze Age.

Most of all, the invention of pottery brought with it the birth of fermentation technology since storing wet cereals, meats, fish, and vegetables in earthen pots naturally produces fermented foods. The invention of fermentation technology could provide relatively abundant nutrients to people compared to previous periods, so it must be related to the sudden increase in population during this period (Lee 2001). For example, cooked soybeans, saltwater, and pottery could have resulted in the birth of fermented soybean products which played an important role not only as a supplementary source of protein but also as palatable sauces enjoyed with cereals, vegetables, and meat. It seems that the *Maek* tribe of the Dongyi,

who were originally meat-eating nomads, enjoyed or invented the soy sauce that has been used for *Maek-chŏk* or *Bulgoki*, roasted meat marinated with soybean sauce, which is one of the favorite foods of Korean people to this day.

The use of soybean product and fermentation technology had continued and developed during the Iron Age that began in Northeast Asia around 500 BC (Nahm 1988). During this period, several proto-states and early states such as Puyŏ, Dongye, Okchŏ, Koguryŏ, and Samhan were established in Manchuria and the Korean Peninsula by the Dongyi people. According to ancient Chinese historical records, such as the *History of the Later Han (Hou Hanshu)* and *Records of the Three Kingdoms (Sanguo Zhi, 3rd c. AD)*, people in these states, the Dongyi, enjoyed drinking wine made of grain. Also, it is written that Chinese people acquired a new kind of soybeans (*rongshu*) from the region of the Dongyi and spread it into China. In *Qiminyaoshu*, the term of *Gaolidou*, literally meaning “soybeans of Koguryŏ,” was used for indicating a good quality of soybeans (Choi 2009). This evidence indicates that the Dongyi largely cultivated high-quality soybeans as their staple food. With fermentation technology, they must have been able to acquire stable and nutritious food sources, which contributed to the creation of proto-states and fully developed state-level society during the Iron Age in Northeast Asia.

Fermented food products such as rice wine, soy sauce, soybean paste, and fish sauce seem to have become the most important food in the dietary culture in and around the Korean Peninsula by the seventh century AD. According to the earliest Korean history, *Samguk Sagi* (1145 AD), rice, rice wine, oil, honey, soy sauce, soybean paste, dried meat, and fish sauce were the most important food items prepared for a wedding in the royal family in Silla in the year 683 AD. It seems that the introduction of Buddhism to the Northeast Asian region from the third to fourth centuries AD contributed to the development of fermented food, thus accelerating the decrease of meat consumption and encouraging the spread of vegetarian food habits. During the 1000-year period following the introduction of

Buddhism, nomadic meat-eating culture gradually disappeared. In its place, the extensive use of salted vegetables and soybean products thrived as the major food source of the Northeast Asian diet. This process also coincided with the invention and development of *Onggi*, glazed earthenware which have been used as containers for fermented products for well over a 1000 years and continue to be used to this day.

People reaching all the way to the northeast end of the continent adapted themselves to their new geographical, ecological, and cultural environments by developing their own dietary cultures and technologies. The dietary culture of Northeast Asia and the birth of fermentation technology in this region in particular have been examined in the context of the use of earthenware beginning in the prehistoric period. The invention of pottery was a significant prerequisite for the long history of fermented food, which dominates the dietary culture of Northeast Asia today. Considering the early appearance of earthenware for food cooking and storing in Northeast Asia, cereal alcoholic beverages, vegetable pickles, and fermented fish and meats were possibly made prior to the beginning of agriculture in this region. The next section of this chapter will be dedicated to a detailed analysis of the history and development of the technology of cereal alcoholic fermentation, vegetable fermentation, fish and meat fermentation, and soybean fermentation in Northeast Asia.

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## 1.3 Origin and Development of Fermentation Technology in Northeast Asia

### 1.3.1 Cereal Alcoholic Fermentation

Alcohol fermentation is considered one of the oldest food-processing technologies human beings have ever had. The production of an alcoholic drink from a cereal is a much more sophisticated affair than making fruit wine, but the process of invention of fermented beer in Northeast Asian culture is nevertheless a mystery. Since the oldest archaeological evidence of