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Geohistorical evolution of kimchi as an ethnic food



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Abstract

Kimchi, a fermented vegetable dish, holds a pivotal role in this culinary tradition, serving not only as a flavor enhancer but also as a crucial source of nutrition. Despite kimchi's significance in Korean dietary culture, its origins and historical evolution have often been subject to misinterpretation. This is largely due to an overreliance on nonscientific, humanities-based approaches to studying kimchi's history, coupled with a lack of interest from the scientific community in exploring its origins. Our approach challenges existing errors and historical misinformation by applying scientific methodologies to the study of kimchi's origins. We examine how factors, such as climate, available ingredients, fermentation techniques, and cultural practices, contributed to kimchi's development. Additionally, we consider the broader context of human migration patterns and agricultural advancements in the Korean peninsula. Through this multidisciplinary lens, we aim to demonstrate that kimchi is not merely a food item, but a reflection of Korea's unique geographical and cultural landscape. This gastro-geohistorical review critically examines historical interpretations of kimchi, offering nuanced insights into its complex historical development and highlighting its significance in Korean and global culinary contexts. By conducting a comprehensive analysis of existing literature, we provided a more rigorous understanding of kimchi's origins and historical trajectory. By offering a scientifically grounded narrative of kimchi's origins, this study contributes to a deeper understanding of how geographical factors and cultural practices intersect in shaping distinctive food traditions. It also highlights the importance of applying rigorous, multidisciplinary approaches to food history research.

Keywords Gastronomy, Geohistory, Kimchi, Origins, Serendipity, Vegetable fermentation

Introduction

The study of food history, particularly iconic ethnic foods like kimchi, presents a complex challenge that requires a multifaceted approach. Traditionally, food historians have relied on two primary methods: literary analysis of historical documents and scientific investigation

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based on human developmental patterns. While the literary approach seems straightforward, especially in cultures with long-standing written traditions, it presents significant limitations when studying the history of kimchi and Korean cuisine more broadly. The challenges of the literary approach are multifold. First, it assumes the existence of comprehensive historical records dating back to ancient times, which is often not the case. Many cultures lacked writing systems for extended periods, and even in documented histories, culinary evolutions were frequently overshadowed by more dramatic events like wars or political upheavals. This limitation is particularly pronounced in Korean food history, where unique writings about culinary evolution are scarce.

Korea's proximity to China has led to a heavy reliance on Chinese characters in historical records, including



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those about food. This has resulted in a tendency for scholars proficient in Chinese to dominate the narrative of Korean food history, sometimes leading to unscientific conclusions about kimchi and other traditional foods. The absence of records in the Korean script before the 15th-century creation of Hangul further complicates the study of early kimchi history. While Chinese literature offers valuable insights, it's crucial to approach these sources with the understanding that Korean culture and cuisine have distinct roots, both scientifically and culturally. Overreliance on Chinese texts to trace kimchi's origin can lead to distortions and errors in our understanding of Korean food history [1-3]. This is particularly important given that kimchi, as we know it today, is a uniquely Korean creation that evolved in response to specific geographical, climatic, and cultural factors.

To address these challenges and provide a more comprehensive understanding of kimchi's history, this manuscript adopts a gastro-geohistorical approach. By integrating literary analysis with scientific inquiry, archaeological evidence, and geographical considerations, we aim to trace the natural and serendipitous origin of kimchi. This method allows us to situate kimchi's evolution within the broader context of human migration patterns, agricultural advancements, and fermentation techniques. Moreover, this approach enables us to explore how kimchi's creation and evolution reflect the unique characteristics of the Korean peninsula, including its climate, available ingredients, and cultural practices. By examining kimchi through this multidisciplinary lens, we can better understand not only its historical trajectory but also its significance in Korean culture and its place in the global culinary landscape.

In this paper, we systematically explore historical interpretations of kimchi that have emerged from uncritical reliance on limited historical sources, particularly Chinese character-based texts. We investigate the factors that contributed to the propagation of these interpretative narratives and their scholarly transmission. This exploration will not only contribute to a more accurate understanding of kimchi's history but also shed light on the complex interplay between geography, culture, and culinary innovation in shaping our food traditions.

Common errors in discussing food history through literature

When discussing food history only through literature, the fatal mistake is made by those who rely on Chinese texts to narrate food history [1-3]. Nevertheless, many scholars proficient in Chinese characters discussed Korean kimchi history, while looking at Chinese

literature, and scientists left their narratives unverified, allowing numerous distortions and errors to permeate our food history today [4, 5]. They fail to move beyond the scientific misconception that the evolutionary trajectory of all world cuisines is merely a result of technical transfer, not cultural diffusion through migration, without acknowledging the diverse scientific factors such as geography, agriculture and culture, and biology that naturally contribute to the origin and evolution of various foods. Instead, they describe this evolution as merely a process of imitation and replication, as recorded in Chinese texts [6].

Another common error, often committed by those lacking scientific thinking, is the assumption that Korean food must have originated from China. However, the absence of records about Korean kimchi in Chinese books leads to the erroneous conclusion that kimchi did not exist in Korea [2, 5]. This spatial error stems from a lack of understanding of the differences in roots and uniqueness between Korean and Chinese cultures. This unfortunate tendency originates from an era dominated by Confucian ideology, where the recording of Chinese characters in literature was prioritized over scientific inquiry.

Moreover, these individuals frequently make the mistake of any mention of kimchi or other foods in a document as the earliest record, easily concluding that these foods did not exist before such documentation [1-6]. However, it is an oversight to forget that many documents have been lost to fires or other reasons, and what remains today may not represent the entirety of historical records. It is essential to recognize that most of human history predates written records [7].

World ethnic foods naturally develop diversely due to environmental and historical contexts. However, the approach of those who attempt to narrate our food through literature, especially Chinese literature, is highly dogmatic and ethnocentric, often failing to acknowledge the diversity of other countries' cuisines. The Confucian ideology prevalent in Korean culture makes it challenging to correct such non-scientific teachings, and even errors are often upheld as virtues of scholarship, reinforcing the confirmation bias. This confirmation bias leads them to selectively accept only the literature that aligns with their beliefs, disregarding contradictory evidence. Consequently, this biased thinking distorts food history, including kimchi, leading to numerous inaccuracies.

Because of these limitations, while it may be possible to infer aspects of food culture like the history of kimchi through Chinese literature, it is crucial to recognize that the roots of Chinese cuisine are entirely different from those of Korea and to approach the subject cautiously [7]. Relying solely on Chinese texts to discuss our food is akin to "telling the story of a chicken's leg with a pheasant's feather," potentially resulting in distortion and error. Due to this error, the history of kimchi, the world's unique and invaluable fermented food, has been significantly distorted, and often falsely attributed to Chinese origins.

Representative misconceptions in kimchi history

Despite kimchi being a uniquely Korean fermented food made primarily with cabbage and other vegetables, researchers solely relied on Chinese literature have consistently distorted the history of kimchi without any scientific basis. "They claim that initially Korean kimchi was made with radishes like China's Pao Cai (泡菜), without using red pepper powder, and that it was a pickled dish. Later, cabbage was used as an ingredient, and red pepper powder was added, making kimchi only about 120 years old" [2–6].

It is disturbing that people have accepted a false narrative of kimchi history for decades, without any objection from food scientists, nutritionists, or biologists, such statements have been accepted merely because they were uttered by professors proficient in Chinese characters, even though they have never made kimchi themselves, unlike our ancestors, especially women, who discovered and developed kimchi despite numerous hardships? Relying solely on historical documents to understand the history of kimchi inherently carries many errors and distortions. It is time for scientists to narrate our kimchi history. However, presenting it scientifically is much more challenging than narrating it based on literature.

Understanding Korean food history through science

Investigating the history of traditional foods requires a comprehensive, interdisciplinary approach that integrates scientific analysis of human origins, migrations, technological developments, and cultural transformations [7–9]. The complex interplay of archaeological evidence, ethnographic studies. geographical changes, and technological innovations provides critical insights into the evolution of culinary traditions. The scarcity of reliable historical sources necessitates a nuanced methodological approach that combines multiple lines of evidence.

To research the ancient history of our food, we should focus on Koreans' writings. Due to the lack of written records by Koreans, our culinary culture has not been extensively documented. Records about the ancient Korean kingdom, Kochosun, are scarce, whether written by Koreans or Chinese. However, the history of Kochosun can be inferred from the records written about the Dankun Myth (檀君神話) in Samguk-yusa (三國遺**事**, Memorabilia of the Three Kingdoms, 1281), written in Chinese character by Monk Ilyeon (一然) [10]. Even in the Three Kings period after Kochosun such as Kokuryo, Baekje, and Shilla in 1-7th centuries, there are very few writings. As for the writings written at the time, the stone monument to Kwangkaeto the Great (廣開土大王) (5th century), engraved on Koguryo's stone, is a record left by our people themselves [11]. We can find out the history of the Three Kingdoms period through the Samguk-saki (三國史記) (History of the Three Kingdoms, 1145) written by Kim Bu-sik later [12]. It should also be recognized that even if there were some books, they were destroyed by fire or war and were not properly propagated to future generations. Even though there were some records for foods in Koryo (10-14th centuries) and Chosun period (15-20 centuries), they mostly focused on the medicinal aspects of food rather than everyday cuisine like kimchi [13, 14]. While it's possible to find some records about Korean cuisine in Chinese literature, they are not plentiful, especially concerning kimchi, which is not a food commonly found in China [15]. Therefore, caution must be exercised when using books written in Chinese characters for kimchi research, regardless of whether they were authored by Koreans or Chinese.

Despite King Sejong's creation and distribution of Hangul [16], an indigenous Korean script, in the 15th century, the aristocracy persisted in using Chinese characters, demeaning Hangul as "vulgar script (eonmun)," or "women's script (anak-gul)", and marginalizing women's domains such as housework. This led to a lack of written records in Korean (Hangul). For this reason, arguing that kimchi is not representative of our cuisine due to the scarcity of records is risky. The challenges in documenting Korean culinary history underscore the importance of interdisciplinary research methodologies that can provide deeper insights into cultural practices and food traditions. By combining scientific analysis with critical examination of available historical sources, researchers can develop a more comprehensive understanding of the complex historical trajectories of traditional foods.

Gastro-geohistorical approach to ethnic foods Human migration and the beginning of agriculture

Food has always been crucial to human survival, shaping our daily lives from the dawn of humanity. Initially, early humans likely spent their days solely focused on gathering food to sustain themselves and their families as they evolved. Human history is essentially a narrative of relentless pursuit for sustenance, involving migration in search of food sources and either settling in new lands or continuing the search elsewhere. The advent of agriculture marked the beginning of settled civilizations, evolving alongside human progress. According to genomic analysis, modern humans (*Homo sapiens*) originated in Africa and dispersed through various routes to settle in Asia [17, 18]. This migration pattern led to the origin of distinct civilizations during the Stone Age, culminating in the emergence of major civilizations such as Egypt, Mesopotamia, the Indus Valley, and the Yellow River (Hwangha, Huanghe, 黃河) Basin. While human migration occurred steadily between 50,000 and 20,000 years ago, it was after the last Ice Age, around 20,000 years ago, that numerous smaller civilizations began to flourish. Those civilizations were characterized by their agricultural, culinary, and religious cultures, with notable differences evident among the four major civilizations.

Although Korea is geographically close to China, the Korean people migrated along the Amur River to establish the distinct Yoha (遼河, Liaohe, this area is now called the northeastern area in China) Civilization concurrently with the Hwangha (黃河, Yellow River) Civilization. Archaeological and evolutionary biology analyses demonstrate that the Yoha Civilization had a unique culture, differing linguistically, culinarily, and biologically from the Hwangha Civilization [7, 19–21]. Thus, the roots of the Korean people lie in the Yoha Civilization including Hwangsan (黃山) Culture.

From the ancient Kochosun era onwards, linguistic roots, such as the transurasian language of the Urals-Altaic family, shaped Korean culture. In contrast, the language of the Hwangha Civilization, prevalent in China, belongs to the Indo-European language family. Geographically, Korea, with its limited plains and abundance of mountains and plateaus, differs from China, which built its agricultural history on vast plains and major rivers. Consequently, Korean cuisine developed independently, enriched by the abundant agricultural regions shaped by human migration patterns and geographical factors [7].

Food is integral to human existence, representing life itself. Early humans devoted their days to finding sustenance for themselves and their families, as eating signifies survival, while hunger portends death. Initially, humans scavenged for edibles that were neither toxic nor indigestible, gradually transitioning to hunting animals for sustenance during the Stone Age. With the advent of the Neolithic era, primitive cultivation began, relying on local crops for sustenance, marking the beginning of agricultural history [22].

When the ancestral Koreans migrated to Northeast Asia, they initially foraged for short-grain rice during the Stone Age. However, around 20,000 years ago, during the Neolithic period, they began cultivating rice, leading to the establishment of agriculturally based communities and the subsequent evolution of an agrarian culture. Unfortunately, the Yoha Civilization, which embodies our cultural heritage, lacks indigenous written records, making it impossible to narrate the culinary history of the Yoha Civilization through primary sources. However, as the Hwangha Civilization had a script represented by Chinese characters (such as oracle bone script or pictographs), it is possible to study the culinary culture of the Hwangha Civilization through historical records.

The birth and evolution of world culinary culture

The discovery of fire and the advent of agriculture marked a significant shift in human dietary habits, transitioning from solely foraging to cultivating grains for consumption. The discovery of fire not only made food safer to eat but also enhanced its flavor. Ultimately, the origin of all traditional cuisines revolves around the fundamental questions of how to safely and deliciously prepare and consume harvested foods. Solving these culinary challenges was not just a matter of survival but also a maternal duty, as unpalatable food would instinctively be rejected by both adults and children, posing a threat to existence. Moreover, the desire to preserve food for later consumption was equally paramount [7].

The discovery of fire significantly addressed these challenges, with the beginning of agricultural history coinciding with the inception of culinary history, directly linked to fire's discovery. Additionally, the discovery of fire was closely intertwined with the advent of pottery and the Bronze and Iron Ages. Without the ability to fire clay vessels, pottery production would have been impossible, and without fire, the smelting of bronze and iron would not have been feasible. Furthermore, the discovery of fire enabled the creation of pottery that could withstand heat, allowing for the safe and flavorful preparation of food. Fermented food cultures such as jang (soy sauces) [23] and kimchi could not have emerged without pottery. Even Western wine culture ultimately owes its existence to the discovery of pottery [24]. Naturally, the pottery of the Hwangha and Yoha Civilizations differed based on the presence or absence of comb patterns [20, 25]. Geographical and agricultural environmental factors largely influenced the origin and evolution of food, with many culinary innovations arising naturally from efforts to make crops more palatable. Additionally, technological advancements, such as improvements in pottery, significantly impacted food safety and flavor.

The quest for safe and palatable food preparation took two main directions: in the West, cooking food directly over the fire or through radiant heat evolved, whereas in the East, techniques such as boiling rice in earthenware or iron pots led to the evolution of safe and flavorful cooking methods. The distinction between Western and Eastern cuisines became evident, with Eastern cuisines often employing indirect heating methods using water or oil to cook food safely and deliciously, as seen in Korean cuisine. The advent of sugar as a widely available commodity since the 18th century has further diversified global culinary cultures, resolving palatability through salt and sugar.

The evolution of all traditional cuisines stemmed not from the importation of technology or knowledge from other countries but rather from the accumulation of wisdom based on the unique geographical and agricultural characteristics of each region or country. Fermented foods, in particular, owe their evolution to such serendipitous discoveries, a phenomenon often regarded as serendipity or a divine gift [7, 23].

Geographical influence on the divergence of European and Korean cuisines

The difference between European and Korean cuisines can largely be distinguished by geographical and agricultural factors, as well as differences in pottery technology. Europe, with its vast plains, where the distinction between fields and paddies is minimal, fostered a culture based on wild grains and livestock, leading to the evolution of wheat and livestock cultures. In contrast, Korea, with its predominantly mountainous terrain, cultivated various grasses and relied on wild rice in the fields, where rice farming or the cultivation of beans and barley in the fields flourished [8]. This represents a difference between wheat and rice cultures agriculturally.

The wheat culture involved cultivating wheat and directly or indirectly baking it over a fire to make bread, while the rice culture evolved into a culinary tradition of cooking rice in pottery with water boiled over the fire. As agricultural cultures settled, they developed into bread and bap (cooked rice, bap also made with barley, kidney beans, millet, and other grains besides rice) cultures, respectively, reflecting differences in baking and rice-cooking techniques. In other words, with the advancement of bread-making techniques even before the Bronze Age, the need for brass or iron pots was not significant, thus maintaining a cultural tradition of directly making bread or pizza using traditional methods. In East Asia, the rice-cooking method evolved significantly with the origin of brass or iron pots, replacing the traditional method of boiling rice in pottery with water poured from pottery. Moreover, in China and Korea, the development of ceramic technology [26] compared to the West led to the evolution of a culture of eating kuk and stew by putting kuk boiled in pots into ceramic bowls [7]. However, China, although it developed similar pottery and ceramic technology, used oil for cooking at high temperatures rather than water, making it impossible to eat due to excessively high temperatures. They eat foods after filtering out the oil, resulting in the absence of kuk culture in China.

When making bread, adding salt enhances the gluten, improving the texture and taste of the bread [7, 27]. This difference is evident in the distinct contrast between Western and Eastern cuisines. Unlike bread, when cooking bap, salt is not added. The reason for this is that adding too much salt disrupts the hydrogen bonds that determine the unique tertiary structure of amylose, leading to starch degradation in rice grains and resulting in less tasty rice. Ultimately, in Korean bap culture, where salt is not used, rice alone cannot be easily eaten. Eating only rice can lead to easily feeling satiated and dissatisfied with the taste, making it impossible to eat more. To solve this problem, the early Koreans had to make every effort to find ways to make food taste better [7].

Finding ways to make food tasty was not an easy task, but it was extremely important because if the food lacked flavor, it could not be eaten no matter how hungry one was. All countries around the world struggled with this problem, and some even engaged in spice wars. Early on, Westerners used fire directly to bake bread or roast meat for consumption. Instead, they sought to solve the problem by seasoning food with salt and spices. China, with its abundant fish and pork oil, used oil in bowls and cooked at high temperatures, making even tasteless food tasty, solving this problem. Furthermore, frying solved the problem of indigestion, reduced moisture activity, and solved the problem of later consumption. How good is this method? Even tropical countries like India, in their pursuit of preserving food and making it tasty, developed a variety of strong spices.

To solve this problem, Koreans had to search for ways to make food taste better. However, all they had were various types of grass growing on the mountains. This led to the unique Korean culinary culture, such as *Yangnyom* culture.

Korean cuisine and Yangnyom (Seasoning) culture

Unlike China, Korea did not have as much oil and instead boiled or blanched food in water, making it less flavorful. There was also no sugar, the most delicious ingredient today. Moreover, unlike the West, Korea did not have an environment conducive to developing livestock, so there was no milk, cheese, or yogurt. Due to geographical factors, the available resources were mainly various vegetables and seasoning ingredients such as peppers, garlic, scallions, and soybeans.

To make bap tasty, it was necessary to have accompanying dishes. These necessary foods are called "banchan" in Korean cuisine [28, 29]. For this reason,

while Western cuisine is understood as "What to eat?", Korean food culture is a culture of "With what banchan to eat bap?" [30]. Most banchan are non-nutrient foods, but our ancestors also made nutrient foods to make up for the lack of protein, which is called "dish". Most commoners could only eat such nutrient dishes on special occasions, while usually, banchan was made mainly from non-nutrient ingredients.

In difficult circumstances without sugar or oil, our ancestors developed a culture of making bap taste the best using the available ingredients. Initially, they used salt to season the food, and as kanjang (soy sauce) and doenjang (soybean paste) developed [23], they used them to enhance the flavor. Later, they made seasoning using garlic, chili powder, and scallions to add flavor. As a result, Korea has developed a unique seasoning culture not found in any other country. Minced garlic removes unwanted odors and enhances the taste, whereas chili powder adds color and taste [7].

Based on this yangnyom culture [7], the most common way of eating vegetables as banchan is to season tender greens raw or blanched at temperatures below 100 °C (60-70 °C) with seasonings (yangnyom). This method greatly enhances the taste of bap. This yangnyom culture represents one of the fundamental directions of world cuisine evolution: how to make food tasty. Our ancestors made countless efforts based on this fundamental philosophy [6], discovering that seasoning vegetables greatly enhances the taste of bap. This is a distinctly different food culture from that of China and Japan.

Origin of kimchi

Typically, tender greens are seasoned with kanjang and eaten as namul (seasoned vegetable) [31], but rougher vegetables are usually seasoned with just kanjang and served as a banchan after being marinated with garlic, scallions, chili powder, and kanjang (or kochujang) [7, 28]. This is what is called the prototype of kimchi, referred to as 'geotjeori' (fresh kimchi) (Fig. 1), which many people still enjoy today. At that time, they would have called kimchi without distinguishing between the current geotjeori shapes. Eating this kimchi with rice makes the bap taste delicious.

Another human desire is for food to be preserved so it can be eaten later, with perhaps even enhanced flavor due to the aging process [7]. Rice bap becomes stale even after half a day, and similarly, most namul (seasoned vegetables) marinated only with kanjang become inedible after just half a day. However, kimchi marinated with yangnyom does not cause stomach upset even after one day, or even several days. Particularly, vegetables such as cabbage, and spinach when soaked in salt before seasoning, are reduced in volume and become much softer, making it much easier and tastier to season. It is not difficult knowledge that must be learned but rather simple wisdom that can be easily obtained: even after

being left for several days, kimchi doesn't spoil and

Fig. 1 Geotjori, the prototype of kimchi, fresh vegetables are

seasoned with yangnyom (red pepper powder, garlic, ginger,

vegetables in the field or garden, and eaten right away

without fermentation

remains edible.

and others). Geotiori kimchi was made immediately after picking

Kimchi has been an inevitable part of our food culture since prehistoric times in Korea due to the geographical environment and agricultural characteristics of Korea. Because garlic, scallions, and chili (called kochu) were available, yangnyom developed, and because there was 'yangnyom culture', kimchi culture emerged. From a modern scientific perspective, kimchi, which can be deliciously eaten through natural fermentation, was spontaneously born through serendipity. The evolution of all traditional foods does not come from importing techniques or knowledge from other countries but rather is made through naturally accumulated wisdom based on the geographical and agricultural uniqueness of that region or country, and ultimately, through serendipitous discoveries. Moreover, the problem of how to preserve food for later consumption was unexpectedly solved. Like a gift from the heavens to the countless efforts of humanity to eat deliciously, fermentation resolves the issue [7]. That is, what would otherwise become inedible if left to rot can be consumed later if fermented.

Without our food culture, bap culture, and our geographical environment, kimchi would not have been discovered. Such serendipitous discoveries apply to other fermented foods like alcohol, vegetable fermentation such as kimchi, grain fermentation such as jang (soybean sauce and paste), as well as European fermented foods





like wine. The notion that kimchi is just a derivative of China's paocai or a simple pickling solution is far from the truth.

The origin of kimchi was not an extraordinarily hightech feat but rather a remarkable culmination of our ancestors' remarkable wisdom. What's even more surprising about kimchi's characteristics is that, unlike other nutrient-rich side dishes, it never becomes boring no matter how much you eat. Therefore, kimchi always occupies the Korean table alongside kuk and jang [7, 28, and 29]. Thus, kimchi takes a central position in the structure of the dining table (bapsang), and Koreans easily understand the saying, "Can't eat bap without kimchi."

There is abundant evidence in many ancient texts supporting the notion that kimchi could only have been born naturally, scientifically, and agriculturally. Therefore, there is a need to properly review ancient texts that have been distorted by confirmation bias by adherents of textualism.

Understanding kimchi's history through literature and relics

As mentioned earlier, a direct cause of distorting the history of kimchi is the misunderstanding of chili peppers in Korea, which has distorted the entire history of kimchi [1-5]. Examining literature that accurately represents chili peppers reveals their importance in Korean and Chinese cuisine, as evidenced by a document from



Fig. 2 Chili tree. Usually, peppers are grown annually for better fruits, but tropical regions such as India and Latin America, which have not been frosted, are ligninized and perennially grown like a tree. This photo was provided by the Chungnam Agricultural Research and Technology

China over 2500 years ago, the Shigyung (時經) (Ancient Chinese book published 2500 years ago), which mentions chili pepper trees (Fig. 2, Figure 13 in [32]). Although Korea does not cultivate chili peppers as perennials, they are already growing as perennials in tropical regions, including India [33]. This indicates that chili peppers, along with garlic, ginger, and scallions, were already key seasoning ingredients in China. There is no biological reason why chili peppers would have been excluded as a food ingredient in ancient Korea [34, 35].

Well-known Korean fermentation literature includes records from the 3rd century, such as the Weishu (魏志, Book of Wei) in Chinese "Samgukji" (三國志, Record of Three Kingdoms of China written by Jinsu in the 3rd century), where it mentions that Kokuryeo (Dongyi, 東夷, 37 BC-668 AD) is skilled in "fermentation." This passage explains the customs of Kokuryeo. Fermentation, in this context, likely includes alcohol, jang (soybean sauce and paste), and kimchi. Since alcohol fermentation and jang fermentation are much more complex and advanced than kimchi fermentation [23], there is no reason why kimchi would not be included in such books.

Supporting this is a record in the same book stating, "Ginger, citrus, chili peppers, and cardamom are ingredients that enhance taste" (有姜, 桔, 椒, 養荷 不知以爲滋 味). Therefore, although it may not be in the form of kimjang kimchi [36], the fermentation of kimchi can be said to have existed even before Kokuryeo. However, due to the absence of pottery vessels suitable for kimchi fermentation during the Neolithic period, although there may have been fermented kimchi in the form of *geotjeori* (prototype of kimchi) (Fig. 1), the proper form of fermented kimchi likely emerged after the discovery of fermentation vessels 5000-6000 years ago.

Though legendary, mentioning garlic in the history of Dankun Choseon in the Samguk-yusa (三國遺事, 1281) [10] supports the principle that seasoning is fundamental to Korean cuisine. Additionally, in the Samguk-saki (\equiv 國史記, History of Korea Three Kingdom, 1145) [12], there is mention of an island called Chodo (椒島, chili island) in the Kokuryeo region. According to the book Mankiryoram (萬機要覽) (published in 1808), this island is described as a place where chili peppers are grown and produced (以産椒故名) [32] (Fig. 3), indicating that kimchi and kochujang were already becoming popular as main banchan [7]. If it were not for the custom or culture of making and eating kimchi or kochujang, there would be no need to cultivate chili peppers. It can be inferred that along with chili peppers, various types of cabbage, radishes, and other vegetables were also cultivated.

One of the oldest records related to kimchi is found in the Samguk-saki and the Koryosa-cholyo (高麗史 節要, Short History of Koryo Kingdom, 1452), where



Fig. 3 A clear proof that chili was grown and cultivated during the Three Kingdoms Period. "Chodo (椒島, chili island)" in the Kokuryeo region is mentioned in the Samguk-saki (三國 史記, History of Korea Three Kingdom) written by Kim Bu-sik (a). Mankiyoram (萬機要覽) (published in 1808) written by Seo YB and Shim SK, explains clearly that Chodo means the island, where chili peppers are cultivated, grown, and produced (以產椒故 名) (b)

it describes people being killed cruelly by being torn apart like kimchi or fermented fish paste (*jeotgal*) [32]. Although this metaphorically likens killing people to eating kimchi, it indicates that tearing and marinating kimchi was a common practice, suggesting that cabbage kimchi was a much-enjoyed dish in the Koryo period (1214-1259).

References to kimchi in literary works such as Hunmongjahoe (訓蒙字會, Dictionary of Chinese scrips for Korean children, 1527) and Naehun (內訓, Bible for woman learning, 1475) and Dusieonhae (杜詩諺**解**, Commentary of Chinese poem by Dubo (杜甫), 1481) show that the Chinese characters for kimchi are written as 'jeo(菹)' and pronounced as 'dimche, dihi.' Regardless, kimchi has been known by the name 'dimche, dihi' in Korea for a long time, and it has been written in Chinese characters as 'jeo(菹)' [37].

In food cultures like China where kimchi is absent, the need or possibility of kimchi's origin does not exist since frying oil can enhance the taste of various foods. However, the term 'jeo ($\bar{\Xi}$)' refers to a food that produces an effect, where vegetables do not rot even in hot or cold weather, as explained in Sokmyong (釋名) (a dictionary published at the end of the Chinese Han (韓) dynasty, BC 2 century). This dictionary's definition of $\bar{\Xi}$ corresponds to the current Chinese preserved vegetable, salted vegetables yomchai (yancai, 鹽菜). However, it cannot be said that these directly correspond to Korean kimchi. Koreans just borrowed this character to describe the kimchi. Detailed reading of the recipes (作菹) in the Chinese book, Jeminyosul (齊民要術) written by Ka Sahyup (532) reveals completely different methods from Korean kimchi. However, efforts to easily understand the history of kimchi by saying that this Chinese 'jeo' influenced kimchi and developed kimchi have led us to distort the history of our kimchi. There is no evidence that Chinese preserved vegetables have a direct influence on Korean kimchi.

As recorded in the Hunmongsahoe, cabbage has long been a staple vegetable in Korean cuisine [7]. Documents such as Dongkuk-isangkukjip (東國李相國集, 1241) by Lee Gyu-bo and Sagajajip (四佳集, 1488) by Seo Keojung provide frequent references to cabbage kimchi, indicating that it has been a primary ingredient in kimchi culture for a considerable period. Additionally, expressions like "the inside of cabbage is soft" found in Chongjangkwanjonseo (青莊館全書, Lee Deok-mu) further emphasize its significance [7, 32]. Despite claims suggesting that cabbage arrived late in Korea (some even argue in the early 20th century) and that radish kimchi preceded cabbage kimchi [2, 38], these assertions are refuted by the documentation, which already distinguishes cabbage by its outer and inner colors, indicating the existence of distinct cabbage varieties [7, 39].

The Bangjunghyangyakmok (方中鄉藥目) in Hyangyak-gugeupbang(鄉藥救急方), compiled during the Koryo period (1214-1259), lists ingredients for kimchi, as radish and cabbage including chili peppers, scallions, seaweed, garlic chives, shepherd's purse, wild aster, among others [7, 32]. Furthermore, Lee Gyu-bo's poem Kapoyukyeong (家圃六詠) (in Dongkuk-isangkukjip, 1241), mentions the use of six vegetables-cucumber, eggplant, radish, scallions, shepherd's purse, and ginger, indicating the long-standing practice of using various vegetables for kimchi. Similarly, historical records such as Sasichanyocho (四時纂要秒, 1482-1483) document the preservation of deodeok (lance asiabell) and bellflower roots, showcasing the diverse array of kimchies (kimchi, dihi, and jangachi).

The discovery of stone jars and urns at Beopjusa Temple believed to date back to the Unified Silla period (668-935 AD), suggests the use of stone vessels for fermenting cabbage or radish for kimchi making [see Figure 5 in [7]). Despite claims suggesting that kimjang culture predates the Unified Silla period due to the presence of large stone jars and urns (pots), there is no evidence to refute this assertion. Records from the early 19th century, such as Nongka-wolryeongka (農家月令歌 by Jeong hakyu), confirm the use of cabbage as the primary ingredient for kimchi. Similarly, the Eunmun-Husaengrok (諺文厚 生錄, List of novel books and information necessary for two women, 19th century) describes the method of layering yangnyom between cabbage leaves to make kimchi. These records indicate the long-standing tradition of fermenting kimchi with yangnyom placed between cabbage leaf layers.

One of the oldest Korean language books on food, "Eumsikdimibang (음식디미방)" by Jang Gyehyang (張桂 香, 1598-1780), provides detailed descriptions of kimchi made with chili peppers [32, 40]. Collectively, these historical documents and artifacts conclusively demonstrate the long-standing presence of cabbage for kimchi making in Korea, with no evidence to refute this conclusion. From before the Three Kingdom period until the construction of Beopjusa Temple (Figure 5 in [7]), cabbage kimchi, and radish kimchi, and *dongchimi* have been representative types of kimchi. Kimjang culture, inseparable from Korea's agricultural heritage (UNESCO) in 2013 and the kimchi tradition, naturally evolved as an integral part of our culinary culture [36].

Over time, kimchi evolved from a side dish (banchan) to a standalone dish. The process of salting cabbage, adding chili powder and various ingredients, and fermenting it in earthenware jars resulted in well-ripened kimchi, which became an essential food in every season, especially in Winter, and a highly developed fermented dish.

The origin of kimchi word

The term 'dimchae($\Box^{\bar{n}}$)', representing kimchi, has changed over time. While the Korean language has been unique for a long time, its written form, Hangul, was created in the 15th century. Therefore, researching the origins of Korean words before the 15th century is quite challenging.

As the roots of the Korean language stem from the transurasian language family, similarities can be found in the languages of ancient Korea, Koguryeo, Koryo, Jurchen and Khitan, Mongolian, and even Sanskrit. Hence, it's difficult to pinpoint the exact origin of the Korean term 'dimchae($\Box^{\frac{1}{2}}$)' for kimchi.

In essence, to trace the roots of the Korean language, one must delve into the Ural-Altaic or Sanskrit languages. However, unfortunately, there aren't many records of these languages available. Moreover, due to the longstanding use of Chinese characters in neighboring China, many scholars have been tempted to seek the roots of the Korean language in Chinese characters. This led to a prevalent belief that the Korean language originated from Chinese characters, fueled by the reverence for Chinese culture during the Chosen Dynasty [2, 5, and 41]. Recognizing these challenges, it becomes imperative to research the origin of kimchi. Therefore, questions about the origins of terms like 'dimchae(딤 친),' 'timchae(팀 친),' 'dihi([l]o])' found in historical texts like Hunmongjahoe, Dusieonhae, Kanibyukonbang (簡易辟瘟方, 1525), and Eoje-naehoon (御製內訓, 1736) remain unanswered. Similarly, asking where these terms came from is akin to questioning the origin of the word 'saram (human in Korea)', which lacks a definitive answer.

In historical texts, kimchi is referred to as '딤 ^{¬¬|} (dimchae)' in Hunmongjahoe, '□[¬¯] (dihi)' in Ducieonhae, and '팀 (timchae)' in Kanibyukonbang and Eojenaehoon. Since the accurate pronunciation of Korean characters wasn't established at the time, various spellings were used. Hence, the origin of the term kimchi could be referred to as Hangul '딤치(팀치)' or $(\lfloor |\bar{o}|)$ [42]. However, it is impossible to determine where this language (Hangul) originated from without knowing the characters of the Korean language. Obviously, the Korean language, the Ural Altai language, has distinctly different roots from the Chinese language, the Indo-European language, and has evolved in different ways [19-21]. And it is too silly to assume that the roots of our food, such as kimchi, come from China, where kimchi is absent. However, despite being linguistically and culturally and foodologically different from China, many of these errors are caused simply by Korean scholars who study etymology trying to find it easily in China.

As for when the term 'dimchae($\begin{bmatrix} I \\ \overline{\neg} I \end{bmatrix}$)' began to be used, some claim it dates back to the Three Kingdoms period. However, due to the limitations of Chinese Scrip literature, it's challenging to ascertain. Generally, it's presumed that the term 'dimchae($\begin{bmatrix} I \\ \overline{\neg} I \end{bmatrix}$)' existed even before the ancient Korean era, during the pre-Koguryeo period, considering that all names come after the existence of the subject itself [7].

While it is evident that kimchi did not originate from Chinese characters, there are records of using Chinese characters like 'jo(菹)' to represent kimchi or creating new Chinese characters to denote kimchi. During a time when Hangul was disregarded, and reverence for Chinese characters prevailed, even though 'Hunminjeongum (訓 民正音, 1446)' was created, people took pride in recording Korean words in Chinese characters. Despite the existence of Korean words like 'dimchae $(\Box^{(n)})$ ' in both spoken and written Korean, some chose to adopt the Chinese character 'jo(菹)' to represent it. In Naehoon (内訓), 'dimchae(딤치)' was transformed into a Chinese character 'chimchae(沉菜)', and there are even instances, where terms like "jangat-ji (장아제) or 장엣디히, dihi (kimchi) in doenjang or kochujang)" were expressed as 'jiyom(漬 鹽)' or 'yomchae(鹽菜)'.

Translating Korean words, especially those related to food, into Chinese characters, which don't have equivalent meanings, can be done in several ways [42]. Firstly, by finding similar Chinese dishes. For example, 'bibimbap (비빔밥)' was translated as 'koldongban(骨董飯)' because there is a Chinese dish resembling it. Secondly, the sound of the Korean word was preserved through phonetic representation in Chinese characters. For instance, 'bibimbap (비빔밥)' was historically rendered as 'bubiban (浮排 飯)' to accurately reflect its pronunciation. Furthermore, combining Chinese characters to create words that sound similar to the Korean term is another approach. Thus, 김치' (kimchi) was translated as 'chimchae(沈菜)' by combining characters that approximate its meaning and sound. Similarly, '김장' (kimjang) was translated as 'chimjang(沈藏)? The character 'chim(沈)' in 'chimchae(沈)' also carries the meaning of 'pickling', making it a fitting translation.

However, translating Korean words into Chinese characters poses challenges, especially concerning the preservation of meaning and pronunciation. Despite translating 'dimche(딤치)' as 'chimchae(沈菜)', some argue that 'dimche $(\Box^{\neg})'$ originated from the Chinese term 'to pickle vegetables (채소를 담그다)' represented by '沈菜', highlighting the dual errors that can occur when interpreting Chinese characters, since because they are meaningful characters. When they translate the Korean word into Chinese words, especially on foods, it cannot be properly translated into a Chinese language, because there is no same food. Moreover, no matter how well they are translated into Chinese when the translated characters are reinterpreted merely by matching the meaning of the original Chinese Characters, there is always an error that can misinterpret the meaning of the Korean language. In particular, it is a big problem when translating into Chinese characters by borrowing sound. This leads to discussions, where kimchi is portrayed as a simple pickled food rather than a fermented food due to microbial fermentation [36]. Understanding the inherent ambiguity of Chinese characters and researching the history of Korean cuisine both theoretically and scientifically can help navigate such debates. Therefore, the appearance of the character 'jo(菹)' in Korean records merely reflects the use of Chinese characters prevalent at the time and holds no relevance between Chinese 'jo(菹)' and kimchi. Looking for the origins of Korean words in Chinese characters is a temptation that often ensnares those unfamiliar with the roots of the language. However, their errors are numerous [2, 3, 41, and 43]. Although our grandmothers who make kimchi might not know our own Hangul (Korean Characters) and may even say, "They don't know the ABCs," the words they create and use are Korean, not the Hanja (Chinese characters) used by nobles who could not even make kimchi.

Once again, the origin of kimchi lies in 'dimchae(치)' or 'timchae(팀치), evolving over time from 'dimchi' 'timchi' to the modern 'kimchi'. When Hangul was created, there was a need to express various pronunciations in Korean as well as to represent Chinese characters in Korean expressions. Consequently, Hangul incorporated many complex consonants and vowels like as dual vowels and dual consonants [44]. However, over time, these complex vowels became monophthongs, and complex consonants underwent consonant shortening, particularly evident in Korean words written in Chinese characters. Due to this vowel shortening phenomenon, 'dimchae(딤치)' changed to 'dimchi(딤치)'. Similarly, 'timchae(팀[¬])' would have changed to 'timchi(팀[¬])' [42, 45], although specific records of this transformation have not been found. This is likely because 'timchae' was relatively less used than 'dimchae'.

Furthermore, during the 18th and 19th centuries, palatalization became pronounced in Korean. Starting from rural areas, especially in Jeolla and Kyongsang Province, sounds like 'd(\subset)' or 't(\in)' before the vowel 'i (|)' changed to palatal consonants 'j(d_5 , π)' and 'ch(\mathfrak{f} , $\tilde{\pi}$).' As 'dimchi($\{\overline{A}|\overline{\lambda}|$)' underwent this palatalization, it changed to 'jimchi($\{\overline{A}|\overline{\lambda}|$)' as seen in Duchang-kyonghumbang (痘瘡經驗方, written by JH Park in 1663) [46]. Regions in the north, like Kwanso (West of North Korea), were relatively resistant to palatalization and the first sound law (頭音法則).

Moreover, in southern regions, 'gi or ki $(\neg |)$ ' pronunciation changed to 'ji $(\overline{\lambda})$ ' due to palatalization, resulting in 'gireum (기름)' becoming 'jireum(지름)' and 'gimseobang (김서방)' becoming 'jimseobang(짐서방)'. People in Seoul developed an aversion to palatalization, even discriminating against those who used palatalized words, calling them 'country bumpkins'. Despite 'jimchi' and 'jilssam' being the correct origins, pronouncing them as 'jimchi' or 'jilssam' led to the false belief that 'gimchi (kimchi)' and 'gilsam' had undergone palatalization [47]. Consequently, to avoid being treated like a country bumpkin, people began pronouncing them as 'kimchi' and 'gilsam'. Eventually, in 1936, 'kimchi' replaced 'jimchi' as the standard term [47, 48]. This phenomenon is called 'fausse régression (false regression (不定回歸), false correction)' [48, 49] and is called 'hyper-correction or hyperurbanism' in English [50]. This regression is similar to the process, where even incorrect words used by Seoul's middle class become standard. Over time, phonetic changes led to the fixed form 'dimchae \rightarrow dimchi · jimchae \rightarrow jimchi \rightarrow kimchi'. Similarly, 'dihi' underwent vowel reduction and palatalization, and became 'dii', 'jii', 'jii', which is used as a suffix in words like *singeonji*, *janji*, and *jangat-ji* (*janga-ji*) to express kimchi. However, they refuse to false regression, keeping the correct name 'ji' instead of 'gi' or 'ki'

Conclusions

This gastro-geohistorical review reveals kimchi as a quintessential product of Korean culinary culture, born from a serendipitous convergence of geographical conditions, agricultural practices, and cultural necessities. Kimchi's evolution is intrinsically tied to Korean bapsang culture, serving as an indispensable banchan that enhances both flavor and nutrition.

Our study provides a detailed analysis of kimchi's historical origins, carefully contextualizing its evolution in relation to other fermented food traditions. We critically evaluate previous comparisons with foods like pao cai or tsukemono, offering a more nuanced interpretation based on rigorous historical and culinary research. Our analysis emphasizes that kimchi's origin and evolution are products of Korea's specific geographical, agronomic, and historical circumstances. From a scientific perspective, kimchi represents a sophisticated natural fermentation process, refined through generations of Korean culinary expertise. Its linguistic journey – from 'dimchae' or 'dihi' to the Chinese character representation 'jo(\overline{a})' – reflects complex cultural exchanges, while underscoring its Korean roots.

This study highlights the importance of applying multidisciplinary, scientifically grounded approaches to food history research. By integrating culinary, geographical, and historical perspectives, we gain a more accurate understanding of kimchi's place in both Korean and global food traditions. This approach not only corrects historical misperceptions but also provides insights into how distinctive food cultures emerge from the interplay of environmental factors, agricultural innovations, and cultural practices. Our gastro-geohistorical approach to kimchi offers a model for studying other food traditions, emphasizing the importance of local contexts and scientific principles in culinary historical research. It underscores the need for interdisciplinary collaboration in food studies to ensure a more comprehensive and accurate representation of culinary heritage worldwide.

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Author contributions

DYK conceptualized and designed manuscript structure and collected the data or wisdom in terms of history and science, KRC surveyed old literature books and documents, SP contributed to conceptualization and writing and JWD contributed to writing & editing.

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Declarations

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