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Original article

Korean traditional fermented fish products: *jeotgal*Ok Kyung Koo^{a,*}, Soo Jung Lee^b, Kyung Rhan Chung^c, Dai Ja Jang^d, Hye Jung Yang^d, Dae Young Kwon^{d,*}^a Department of Food and Nutrition, Gyeongsang National University, Jinju, South Korea^b Institute of Agriculture and Life Science, Gyeongsang National University, Jinju, South Korea^c The Academy of Korean Studies, Songnam, South Korea^d Food Safety Research Group, Korea Food Research Institute, Songnam, South Korea

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ABSTRACT

Jeotgal (醃) is a traditional Korean fermented food with thousands years of history with *kimchi* and other *jang* (fermented soybean products, 醬). The history was proved by research from historical literature and antique architecture. *Jeotgal* was developed along with *jang* (豆醬), fish *jang* (魚醬), meat *jang* (肉醬) as a part of *jang* (醬) up to the Chosun Dynasty and it was always offered during the ancestral rites or ceremonies. According to antique documents written by women, *jeotgal* had been used as seasonings or condiments that were popular especially for women rather than as food served for ancestral rites. In Southeast Asia and other countries, *jeotgal* uses varieties of fish and seafoods to provide rich and varied flavors, and thanks to the next generation sequencing technology, we can identify microorganisms that are involved in the fermentation process. Major microorganisms in *jeotgal* are *Bacillus*, *Brevibacterium*, *Micrococcus*, *Pediococcus*, *Pseudomonas*, *Lactobacillus*, *Leuconostoc*, and *Halobacterium*. Recently, much research on various health function of *jeotgal* has been conducted, reflecting increasing interest in the safety and the functionality of *jeotgal*. Many reports on functionalities of *jeotgal* such as supplying essential amino acids, and having antioxidant and antitumorigenic have been published recently. Because of the diverse flavor, types, and their function, *jeotgal* is expected to continue to develop as an important seasoning in the world sauce market.

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1. Introduction

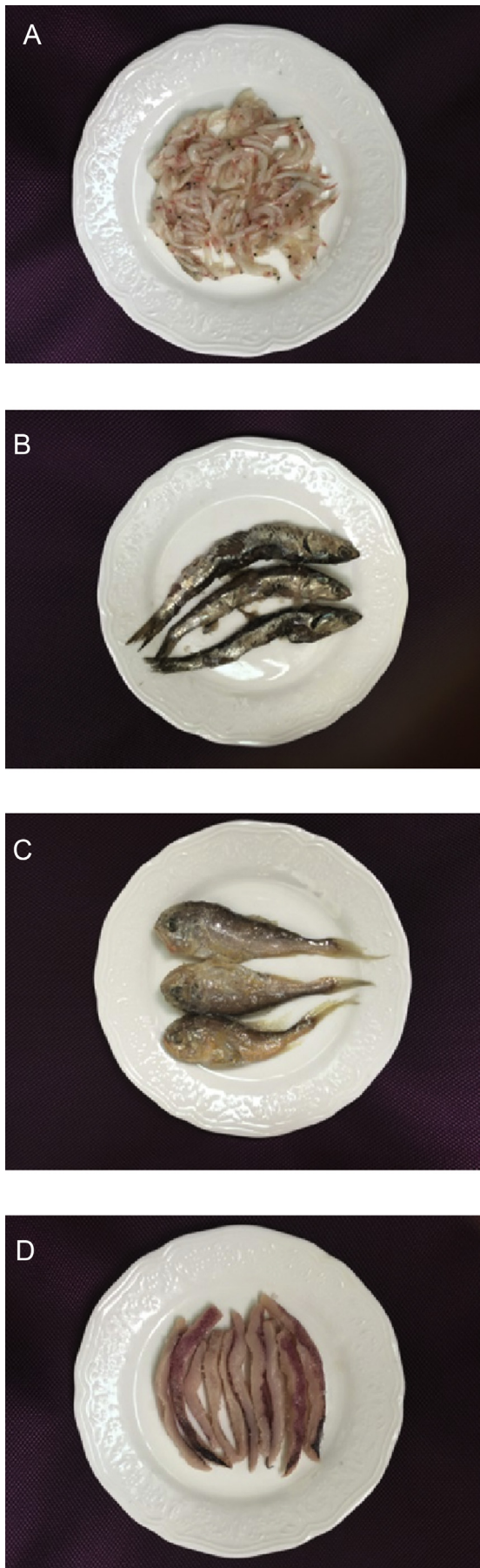
Much of the food technology development in food products has been motivated by the desire to preserve food in good condition for future consumption [1]. Each country has developed unique ways of preserving food, especially meat and fish. The most prevalent method of preservation is through reducing water activity by adding salt or drying, which protects against microbial spoilage by inhibiting the growth of harmful microorganisms. Fish, for example, was usually salted down immediately in order to prevent spoilage. It is presumed that food would ferment during this preservation process by beneficial microorganisms. As

fermentation does not lead to any health issues, people would have continued to consume fermented foods even if they had never come to understand how fermentation changes food. In the Orient, fermented foods have been produced using beans, fish, and meat, and the general term for these products is *jang* (醬) [2,3]. *Jang* made from beans is referred to as *dujang* (豆醬, soy *jang*), from fish as *eojang* (魚醬, fish *jang*), and from meat as *yukjang* (肉醬, meat *jang*) [3]. *Dujang*, a representative type of *jang* in Korea, has been discussed previously in this journal [4]. At present times, the variation in *yukjang* (肉醬) such as this was limited, although *jang-jorim*, beef salted in soy sauce, was widely enjoyed, [1,5]. The most preferred type of salted and fermented food in Korea is *eojang* (魚醬), which is made with salted fish and is referred to as *jeotgal*. Fermented fish products have developed into other unique forms across East Asia, Southeast Asia, and Europe.

Fermented fish products have been consumed as the fish itself, fish sauce, fish paste, and other types of food throughout the world. some of the examples of fish sauces are *jeotkal* in Korea [6], *shott-suru* from Japan [7], *nuoc-man* from Vietnam [3], various fermented

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fish products in India [8], *hakarl* in northern Europe [9], and Worcestershire sauce in England, which is mostly manufactured from anchovies; these are liquid type of sauces [10]. Fish pastes, which are made with minced or blended fish or shellfish include *padaek* from Laos, *prahok* from Cambodia, and shrimp paste from China [10]. These types of food are consumed as proteinaceous staples or condiments in Southeast Asia while northern Europeans consume them as condiments [8]. Korean *jeotgal* refers to both liquid and paste types of fermented fish foods.

Jeotgal is a traditional fermented fish food in Korea that is produced from the whole meat (Fig. 1) and/or internal organs of fish and shellfish (Fig. 2), salted and fermented for inhibition of spoilage, for autolysis, and for decomposing the main ingredients by microbial activities [11,12]. Unlike salted food to minimize the decomposition of the meat by harmful microorganisms, *jeotgal* produces a unique flavor during the protein decomposition of raw materials by beneficial organisms. As *jeotgal* has thousands of years of history, it has its own unique and many different characters [2,13]. Not only does proteolysis proceed during fermentation, but also carbohydrates, lipids, and organic acids are broken down to enhance the flavor, so that *jeotgal* is one of the important sub-ingredients or seasonings in *kimchi* and other Korean foods [14]. Traditionally, fish products have been a great source of protein in the Korean diet, but have varied in how they are consumed. For example, *hongeo* (fermented skate) [15] (Fig. 3A) is prepared with strong fermentation while *gulbi* (salted yellow corvina) [15] (Fig. 3B) is preserved by salting and drying without additional fermentation. In preparations such as *myeongtae* (dried pollock) and *hwangtae* (dried, aged pollock), another fish product for protein source, fish are frozen first and then dried to prevent spoilage without adding salt [16].

Jeotgal has great nutritional value with additional function to our health including appetite, digestion, and beneficial microorganisms. Many reports have focused on the production of Korean fermented fish products [11,17]. However, there are a few papers on the historical/cultural background and value added and beneficial effects of Korean fermented fishery products. Moreover, *jeotgal* has been underestimated as a food with high sodium content. Therefore, we have evaluated this high-added value food, *jeotgal*, from the history to the scientific data analysis in this article. We will discuss the origin and history of *jeotgal*, characterize and classify different types of *jeotgal* and provide the microbial community and health functional information of *jeotgal*.

2. History of *jeotgal*

Hae (醃; Fig. 4) is the Chinese character that generally represents *jeotgal*. Written references to this character are found in historical Chinese literature, including the *Sigyung* (詩經; BCE 551–477) [19] and *Lyeki* (禮記) [20], a book that details the courtesy observed during the Zhou (周) dynasty (BCE 1046–256), although written later, in the Han (漢) dynasty (BCE 202–CE 220). Although the references mainly discuss *yukjang* (肉醬), salted or fermented meat products, the use of term *ranhae* (卵鯉) suggests that *eojang* (魚醬) might have existed as a type of *jeotgal*. *Ja* (鮓), the Chinese character referring to *jeotgal* made with fish, first appeared in the *Cheminyosul* (齊民要術; CE 532), written by Ka (賈思勰) of the Shandong peninsula (山東半島) in China [2]. At that time, the Yodong peninsula (遼東半島) was under Kokuryu (高句麗, BCE 37–CE 668) rule, and there were many interactions among Kokuryu, Baekje (百濟, BCE

Fig. 1. *Jeotgal* prepared with whole fish by adding salt. (A) *Saeu-jeot* (small shrimp *jeot*), (B) *myeolchi-jeot* (anchovy *jeot*), (C) *whangseokeojeot* (yellow corvina *jeot*), and (D) *ojingeojeot* (squid *jeot*). (See Table 1.)

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