HOSTED BY

ELSEVIER

CrossMark

Available online at www.sciencedirect.com

ScienceDirect

Food Science and Human Wellness 4 (2015) 47–55

Food Science and Human Wellness

www.elsevier.com/locate/fshw

A review: Health promoting lactic acid bacteria in traditional Indonesian fermented foods

Lilis Nuraida *

Southeast Asian Food and Agricultural Science and Technology (SEAFAST) Center, and Department of Food Science and Technology, Bogor Agricultural University, Indonesia

Received 23 November 2014; received in revised form 8 December 2014; accepted 29 January 2015

Abstract

Traditional Indonesian fermented foods can be used as potential sources of probiotics as they commonly contain lactic acid bacteria (LAB), including species of *Lactobacillus*, *Pediococcus*, *Enterococcus*, *Weisella* and *Leuconostoc*. The occurrence of LAB in Indonesian fermented foods is not only limited to lactic fermented foods but is also present in foods with molds as the main starter culture. This review aims to describe the significance of Indonesian fermented foods as potential sources of probiotics and the potential of LAB from fermented foods to promote beneficial health effects. A number of *in vitro* studies have been carried out to assess the probiotic potential of LAB from fermented foods. Many LAB strains have met the basic requirements for them to be considered as probiotics and possess some functional properties contributing to positive health impacts. Hypocholesterolemic effects, stimulation of the immune system, and prevention of diarrhea by some probiotic strains have been shown in animal studies. However, human studies on the efficacy of probiotic strains are still limited. Two strains isolated from dadih, a fermented buffalo milk, are examples of promising probiotic strains that have gone through human studies. The potential probiotic properties of LAB in Indonesian fermented foods still need to be fully investigated to assess their impact on human health. The studies should also consider factors that may influence the functional properties of probiotics, both in foods and in humans.

Keywords: Fermented foods; Probiotics; Diarrhea; Hypocholesterolemic; Antimutagenicity

1. Introduction

Fermentation is known as one of the oldest forms of food preservation in the world. Fermentation can increase the shelf-life of meat, fish, fruit and vegetables that are highly perishable due to their high water contents and nutritive values, especially in tropical countries like Indonesia. Preservation of foods occurs through lactic acid, alcoholic, acetic acid and high salt fermentations. Beside preserving foods, fermentation also changes the organoleptic characteristics of foods through developing a wide diversity of flavors, aromas and textures. Moreover, fermentation may improve digestibility and nutritional quality through enrichment of food substrates with vitamins, proteins, essential amino acids and essential fatty acids [1,2].

As in other parts of East Asia, Indonesian fermented foods feature the use of a variety of raw materials, including cereals, soybeans, fruits, vegetables, tubers and fish. In some parts of Indonesia, meat and milk, especially buffalo milk and mare milk, have been used traditionally as raw materials for fermented products. In terms of the fermentation processes, Indonesian fermented foods can be classified into lactic fermentations (fruits, vegetables, cassava, meat, milk), alcoholic fermentations (rice, cassava), mold fermentations (soybeans, peanut press cake) and high salt fermentations (fish, soy sauce, tauco [fermented soybean slurry]). In the fermentation of some products, such as soy

* Correspondence to: SEAFAST Building, Jl. Puspa No. 1, IPB Darmaga Campus, Bogor, Indonesia. Tel.: +62 251 8629903; fax: +62 251 8629535.
E-mail address: lilis@seafast.org
Peer review under responsibility of Beijing Academy of Food Sciences.

http://dx.doi.org/10.1016/j.fshw.2015.06.001

sauce, a mold fermentation is followed by a brine fermentation in which LAB and yeasts are involved [3].

Although some fermentations, such as those for tempe (mold fermented soybean) and tape (alcoholic fermented steamed glutinuous rice or cassava), use a starter culture, microorganisms from the environment may contaminate the ferments and grow during the fermentations. Involvement of microorganisms other than molds in tempe fermentation has started since soaking step and continues during mold fermentation [4,5]. The presence of other microorganisms such as LAB in tape fermentation contributes to the development of flavor of tape [6]. Many Indonesian fermented foods (fruits, vegetables, meat and fish) are produced through natural fermentation by controlling the environment with the addition of salt, or by soaking the raw materials in water, as in the fermentation of raw peeled cassava root. The main role of salt in fruit and vegetable fermentations is to promote the growth of LAB over spoilage bacteria [7,8] and to inhibit pectinolytic and proteolytic enzymes that can cause softening and putrefaction [7].

LAB is a group of Gram-positive, non-spore forming, coccus or rod shaped bacteria. They ferment carbohydrates to almost entirely lactic acid (homofermentation) or to a mixture of lactic acid, carbon dioxide and acetic acid and/or ethanol (heterofermentation). Other compounds, such as diacetyl, acetaldehyde and hydrogen peroxide, are also produced. These compounds contribute to the flavor and texture of fermented foods and may also contribute to the inhibition of undesirable microbes.

The LAB in Asian traditional fermented foods include *Lactobacillus plantarum*, *Lb. pentosus*, *Lb. brevis*, *Lb. fermentum*, *Lb. casei*, *Leuconostoc mesenteroides*, *Leu. kimchi*, *Leu. fallax*, *Weissella confusa*, *W. koreenis*, *W. cibaria*, and *Pediococcus pentosaceus*, many of which are considered to be potential probiotics [7]. Most of the LAB present in Indonesian fermented foods are *Lactobacillus* species (Table 1). Other genera, such as *Pediococcus*, *Lactococcus*, *Enterococcus*, *Weisella* and *Leuconostoc*, are also found in some fermented foods (Table 1). LAB are involved to varying degrees in Asian fermented foods, and may have positive and negative effects on products [9]. In cereal alcoholic fermentations, lactic acid bacteria contribute to the characteristic of flavor and taste. Excessive lactic acid generally lowers the quality of alcoholic fermentation products. However, in fruit, vegetable, milk and meat fermentations, LAB play a major role in producing acid necessary to the quality of the products. It is interesting that LAB are generally present in tempe, which is not an acidic fermentation. In tempe fermentation, soybeans are soaked overnight prior to inoculation with starter culture containing *Rhizopus oligosporus* as the primary microorganism. Acid fermentation involving LAB takes place during the soaking [10,11] and some growth of lactic acid bacteria commonly occurs during the stage of mold growth [5,12].

LAB in fermented foods are of interest not only for their role in fermentation but also for their role in promoting positive health impacts. The concept of beneficial health effects of LAB has existed since Metchnicoff in 1908 proposed that acid producing microorganisms in fermented dairy products could lead to a prolongation of the life span of consumers [36]. Although historically the fermented products associated with beneficial LAB were milk-based, much research has been directed to exploring LAB from other fermented foods as potential probiotics. A probiotic is defined as a live microorganism that will confer beneficial effects on the host when ingested in sufficient amount [37]. The probiotic bacteria used in commercial products are mainly members of the genera *Lactobacillus* and *Bifidobacterium* [36]. Probiotic bacteria are usually those bacteria that have adapted to the gastrointestinal environment. However, recent research has shown promising probiotic activity of LAB isolated from fermented foods [9]. The progress in research on the beneficial health effects of microorganisms, especially LAB, isolated from Indonesian fermented foods is discussed below.

2. Potential of lactic acid bacteria isolated from Indonesian fermented foods as probiotics

Probiotic and other functional properties are strain dependent and all probiotic strains are unique and different; therefore, their properties and characteristics need to be well defined [38]. Several criteria have to be met in selecting probiotic strains, including acid and bile tolerance, survival through the gastrointestinal track, ability to adhere to intestinal surfaces, antimicrobial activity against potentially pathogenic bacteria, and good technological properties [39]. Functional properties of probiotics include hypocholesterolemic activity by lowering plasma cholesterol [40], preventing and treating diarrhea [37], and altering the immune system [41,42]. The mechanisms by which probiotics exert their beneficial effects on the host include the reduction of luminal pH, competition with pathogens for adhesion sites and nutritional sources, secretion of antimicrobial substances, toxin inactivation, and immune stimulation [43].

Based on *in vitro* studies, LAB isolated from Indonesian fermented foods have promising characteristics as probiotic candidates (Table 2). *In vitro* assessment shows that many LAB isolates tolerate bile salt and low pH environment and possess antagonistic activity against foodborne pathogens. These characteristics are similar to those of intestinal microorganisms, such as *Lactobacillus acidophillus* and *Lb. casei* that are commonly used as probiotics [9]. The research results suggest that the LAB in Indonesian fermented food have adapted to environments that resemble the gastrointestinal track and, hence, have potential as probiotic microorganisms. Adaptation of LAB isolated from fermented foods on specific environment such as high salt concentration, acidic condition, has also been reported such as *L. mesenteroides* in Kimchii, cane juice, *Leu. oenos* in grape juice and *Tetragenococcus halophillus* in soy sauce [9]. It has been suggested that adaptation involves the human food cycle, from soil to raw materials, to fermented product, to human intestine, to feces and then to soil again [9].