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ORIGINAL ARTICLE

In vitro importance of probiotic *Lactobacillus plantarum* related to medical field

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Abstract *Lactobacillus plantarum* is a Gram positive lactic acid bacterium commonly found in fermented food and in the gastro intestinal tract and is commonly used in the food industry as a potential starter probiotic. Recently, the consumption of food together with probiotics has tremendously increased. Among the lactic acid bacteria, *L. plantarum* attracted many researchers because of its wide applications in the medical field with antioxidant, anticancer, anti-inflammatory, antiproliferative, anti-obesity and antidiabetic properties. The present study aimed to investigate the in vitro importance of *L. plantarum* toward medical applications. Moreover, this report short listed various reports related to the applications of this promising strain. In conclusion, this study would attract the researchers in commercializing this strain toward the welfare of humans related to medical needs.

1. Introduction

The human digestive system contains approximately four hundred different bacterial species and its abundance differs between individuals. Among them few probiotic *Lactobacillus* species namely, *Lactobacillus acidophilus*, *Lactobacillus pentosus*, *Lactobacillus brevis*, *Lactobacillus lactis*, *Lactobacillus amylovorus*, *Lactobacillus casei*, *Lactobacillus bulgaricus*, *Lactobacillus fermentum*, *Lactobacillus plantarum* and *Lactobacillus rhamnosus* specifically produce extracellular proteins, exopolysaccharides, bacteriocins and lipoteichoic acids which influence the health and physiology of the host by interacting with the epithelial cells and enhance the host immune system (Sanchez et al., 2010). *Lactobacillus* strains are recognized as safe for consumption because of their presence in food and their role in the gut defense mechanism. Of the *Lactobacillus* strains, *L. plantarum* is a Gram positive, short-rod, micro-aerophilic, acid-tolerant, non-spore forming,

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non-respiring, low G + C content, hetero-fermentative group of lactobacilli with a range of applications in the food industry as a starter culture and preservatives (Arasu et al., 2013). It is a non-spore forming bacterium which produces organic acids such as acetic acid, succinic acid and lactic acid as major metabolites. The antibacterial, antifungal and probiotic properties of LAB strains have been widely studied (Rejiniemon et al., 2015). *L. plantarum* grow under low buffering capacity in the stomach and other complex bile salt secretions in humans and other mammals. Besides applications in the food industry, *L. plantarum* has wide applications in the pharma industry by contributing significantly to human medicine without contributing to any side effects. Recently, *L. plantarum* has been applied in medical fields for the treatment of various chronic and cardiovascular diseases such as Alzheimer's, Parkinson's, diabetes, obesity, cancer, hypertension, urinogenital complications, liver disorders, etc. (Woo et al., 2014). The present study aimed to investigate the in vitro importance of *L. plantarum* related to the medical field.

2. Materials and methods

2.1. Isolation of Lactobacillus strains

Novel *L. plantarum* was isolated from the silage (Arasu et al., 2013). For the isolation process, the silage sample was serially diluted and spread on de Man–Rogosa (MRS) agar and incubated at 37 °C for three days. Morphological, biochemical and physiological characteristics of the strains were examined by following the reported literature. Phenotypic characteristics were studied using API 50CHB kits. The growth and fermentation patent of the strains under various sugars were determined by following the standard method.

2.2. Importance of L. plantarum

The in vitro application of the *L. plantarum* was reported by many researchers. Besides the applications of these strains in our lab, the importance of these strains reported by other researchers was summarized in this report.

3. Results and discussion

3.1. Identification and characterization of L. plantarum strains

The fermented food is commonly known for the presence of *Lactobacillus* strains. Besides protecting the nutritional quality, *Lactobacillus* strains were used for protecting the fermented food from various fungal pathogens. Many beneficial species of *Lactobacillus* strains were derived from the fermented food and other silage samples. The routine microbiological identification methods and 16S rRNA gene amplification followed by sequencing identified the strain as *L. plantarum* (Arasu et al., 2013). The physiological and biochemical identification study showed that the strain was catalase negative, Gram positive (Fig. 1). This novel strain was tolerant to a different range of salts especially NaCl and bile salts, pH of 4.0–8.0, temperatures of 28–45 °C, and with optimum cell growth at a temperature of 37 °C and pH 7.0 respectively. Similar to the literature the identified strain

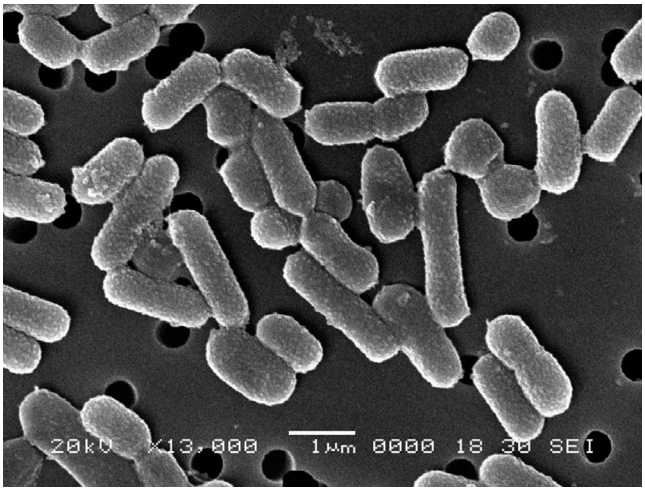

Figure 1 Micro-morphological image of *Lactobacillus plantarum* strain.

survived various biological barriers such as low pH, lytic enzymes, and bile salts in the upper GI tract (Vijayakumar et al., 2015). Carbohydrate assimilation test concluded that the strain was able to utilize a wide range of sugars especially monosaccharide's and disaccharides respectively. Moreover, the production of extracellular enzymes such as amylase and protease was to its advantage. The above mentioned results were commonly observed in *L. plantarum* strains.

The bile salt tolerance level of the *Lactobacillus* strains was induced by the expression of proteins such as GshR4, Cfa2, Bsh1, OpuA, and AtpH (Hamon et al., 2011). Besides the tolerance level, the antagonistic properties of the novel *Lactobacillus* strains are important to prevent the spreading of the intestinal infections. In general, the probiotic *Lactobacillus* strains exhibited significant antimicrobial activity against various GI tract pathogens. The antimicrobial properties of the strains were mainly related to the secretion of the extracellular metabolites such as lactic acid, acetic acid, succinic acid, and bacteriocins.

3.2. Importance L. plantarum strains

Literature claimed that *L. plantarum* strains were widely studied for their applications in the medical field (Table 1). Especially, these strains were reported to posses the down regulation of the risk of cardiovascular diseases (Ahren et al., 2014), produce pro-inflammatory cytokines in the intestinal epithelial cells (Murofushi et al., 2015), produce varied concentrations of exopolysaccharide with anticancer property (Wang et al., 2014), reduce kidney stones (Sasikumar et al., 2014), enhance splenocytes in dendritic cells (Ku et al., 2014) and reduce the cholesterol level in the adipose tissue (Li et al., 2014. Recently, Ilavenil et al. (2015) claimed that the phenyl lactic acid recovered from L. plantarum promotes adipogenic activity in 3T3-L1. Interestingly, *L. plantarum* significantly induces mucosal, humoral and cellular immune responses (Shi et al., 2014) and protects against symptoms of irritable bowel syndrome (Stevenson et al., 2014). It inhibited the production of pro-inflammatory cytokines such as NF-κB and suppresses atherosclerotic plaque inflammation