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ORIGINAL ARTICLE

Selected lactobacilli and bifidobacteria development in solid state fermentation using soybean paste

Antonieta Rodríguez de Olmos, Maria Alejandra Correa Deza, Marisa S. Garro*

Centro de Referencia para Lactobacilos (CERELA-CONICET), Chacabuco 145, (T4000ILC) San Miguel de Tucumán, Tucumán, Argentina

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Abstract At present, consumers are looking for more natural foods so as to improve health through their active compounds. Within this context, soybean is an excellent substrate due to its beneficial effects on consumers' health. Moreover, lactic cultures are widely used in the food industry to improve the technological, nutritional and functional characteristics of fermented foods. It is interesting to find new matrices in which to transport these starter cultures (potentially probiotic microorganisms). The aim of this research was to obtain a solid state fermentation system from soybean to analyze the behavior of selected lactobacilli and bifidobacteria, with the potential to develop a functional vegetarian food to serve as carrier for the microorganisms. A soybean solid substrate system was optimized by selecting the relationship of the main processing parameters. Homogeneous soybean pastes with different moisture content (60–80%) were obtained and used as substrate and support for solid substrate fermentation. Moisture, inoculum size and temperature were optimized: 80%, 4%, 37 °C, respectively. *L. rhamnosus* CRL 981 was chosen as the best starter to use in this kind of fermentation, showing high acidification and cell counts at 24 h of fermentation and increased specific growth rate in tested soybean pastes. It was demonstrated that the selected soybean paste could be used as a carrier of these microorganisms having probiotic potential for the production of vegetarian foods. Moreover, these microorganisms are able to modify the substrate to enhance their nutritional and functional characteristics, which would change the soybean into a more attractive product for consumers.

* Corresponding author.
E-mail address: mgarro@cerela.org.ar (M.S. Garro).

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PALABRAS CLAVE
Fermentación en sustrato sólido;
Soja;
Lactobacilos;
Bifidobacterias;
Alimento portador

Desarrollo de lactobacilos y bifidobacterias seleccionadas en fermentación en estado sólido utilizando pasta de soja

Resumen Actualmente los consumidores están en la búsqueda de alimentos naturales, a fin de mejorar la salud a través de sus compuestos activos. En este contexto, la soja es un excelente sustrato debido a sus efectos beneficiosos sobre la salud del consumidor. En la industria alimentaria se emplean cultivos lácticos para mejorar las características tecnológicas, nutricionales y funcionales de los alimentos fermentados. Es interesante encontrar nuevas matrices para transportar estos cultivos iniciadores, que potencialmente son microorganismos probióticos. El objetivo de este estudio fue obtener un sistema de fermentación en estado sólido a partir de soja para analizar el comportamiento de lactobacilos y bifidobacterias seleccionadas, con potencial para desarrollar un alimento vegetariano funcional que sirva de portador de los microorganismos. El sistema de sustrato sólido de soja se optimizó mediante la selección de la relación de parámetros principales de procesamiento. Se obtuvieron pastas de soja homogéneas con diferente contenido humedad (60-80%) y se utilizaron como sustrato y soporte para la fermentación en sustrato sólido. Las variables humedad, tamaño del inóculo y temperatura fueron optimizadas en 80%, 4% y 37°C, respectivamente. *Lactobacillus rhamnosus* CRL 981 fue elegido como el mejor cultivo iniciador para utilizar en este tipo de fermentación; este mostró acidificación y recuentos celulares altos en 24 horas de fermentación, y mayor velocidad específica de crecimiento en las condiciones evaluadas. Se demostró que la pasta de soja seleccionada podría ser utilizada como portadora de estos microorganismos con potencial probiótico para la elaboración de alimentos vegetarianos. Además, estos microorganismos son capaces de modificar el sustrato y mejorar sus características nutritivas y funcionales, lo que convertiría a la soja en un producto más atractivo para los consumidores.

Introduction

Solid state fermentation (SSF) is an alternative tool to obtain new products for human consumption. In the last years SSF has been appreciated due to the fact that its process uses industrial and household waste, byproducts of industries and raw materials (such as legumes and cereals) as substrate. Moreover, the major advantages of the SSF process are the higher yield of products and less water need in up-stream processing resulting in lesser wastewater generation in downstream processing[4,18]. In SSF the microorganisms grow on moist solid substrates in the absence of free flowing water. Many microorganisms can be used in SSF[5,12,18,20]; it was previously thought that only fungi and yeasts were able to grow in this type of fermentation because the bacteria require higher water activities. Therefore, research was oriented to the use of fungi and yeasts in SSF and there are few publications using bacteria[9,18].

Furthermore, lactic acid bacteria (LAB) and bifidobacteria are microorganisms that play a key role in fermented food and beverages, contributing not only to the development of the desired sensory properties in the end product but also to their microbiological safety. LAB and bifidobacterias have GRAS (Generally Recognized As Safe) status and their action as probiotic microorganisms with their effect in the host was recognized in the last years[16,24].

Most of the research work about LAB was done using submerged fermentation. Several studies using SSF for the production of lactic acid from agro-industrial waste have been developed[10,11,17]. Moreover, the effect of lactic acid bacteria in solid state fermentation using different kind of substrates has recently been studied[3,19,23]. However few studies based on the optimization of kinetic and technological parameters of lactic bacteria in FSS were developed for the production of food.

Soybean is an excellent substrate for the production of functional foods due to its low cost and high nutritional value (high content of proteins, presence of carbohydrates such as sucrose, raffinose, and stachyose, lipids and other components). In our country there is great availability of this legume, being the third largest producer and exporter[6]. However, consumption of soybeans in Argentina is low mainly because of our different food culture and due to the characteristic beany flavor and the presence of certain anti-nutritional factors. Some anti-nutritional factors of soybeans can be reduced with thermal treatments or lactic fermentation[7].

The aim of this research was to obtain a solid state fermentation system from soybean to analyze the behavior of selected strains of lactobacilli and bifidobacteria in order to increase the knowledge to develop a functional vegetarian food as carrier for the microorganisms. These systems could improve the nutritional and functional properties of the soybean substrate. In addition, the effects of the inoculum size and temperature on the behavior of a selected strain were evaluated.

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