



# Functional properties of lactic acid bacteria in fermented fruit and vegetable juices: a systematic literature review

Julia Szutowaska<sup>1</sup>

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## Abstract

The development of non-dairy fermented juices based on fruits and vegetables is favoured by multiple factors, such as greater consumer awareness of health-related properties of fermented foods, a growing number of lactose intolerance cases, and an increasing popularity of food trends like veganism. Therefore, the scientific community's interest in the design of lactic acid fermented juices and determining their functional features has increased over the past 10 years. The aim of this study was to review the latest reports concerning the influence of lactic acid bacteria on fermented fruit and vegetable juices, using the SALSA (search, appraisal, synthesis, analysis) systematic literature review framework. This approach allowed for gathering 42 most essential publications, which have undergone detailed analysis. Most studies focused on the functional properties of fruit juices (e.g. cashew apple or pomegranate juice), while vegetable (e.g. tomato or carrot juice) and mixed juices (e.g. apple–carrot juice) were studied in a lesser extent. Recent studies indicate a great commercialization potential of non-dairy fermented juices due to their adequate probiotic delivery; strong antimicrobial and antioxidant properties; high content of vitamins, total phenols, amino acids, exopolysaccharides; unique sensory characteristics as well as their anticancer, antidiabetic, and anti-inflammatory activities. All these advantages are strictly associated with the use of particular bacterial strain (mostly strains of *L. plantarum*) and plant matrices.

**Keywords** Fruits · Fermentation · Lactic acid bacteria · Non-dairy fermented products · Probiotics · Vegetables

## Introduction

In recent years, fermented juices based on fruits or vegetables have received considerable attention from health-conscious consumers, producers of functional foods, and researchers [1, 2]. This tendency is associated with a growing number of people with lactose intolerance, allergy to cow's milk protein, or high cholesterol [2, 3]. Increasingly popular trends such as veganism and vegetarianism, as well consumers' interest in innovative and functional foods, promote the development of this product category [2]. Additionally, the growing number of scientific reports demonstrating the positive impact of fermented foods on human health contributes to their greater popularity and consumption [4].

Fermented foods have accompanied humanity since ancient times, and fermentation is one of the oldest preservation methods. A number of fermented fruit and vegetable products, like sauerkraut or kimchi, have been consumed for ages and hold a special place in the traditions of many cultures [5]. Nowadays, the process of lactic acid fermentation may be carried out via three different procedures: (1) spontaneous fermentation with naturally occurring microbiota; (2) back-slopping, based on continuous passage of food-adapted microorganisms; and (3) controlled fermentation using selected, examined starter cultures [4] (Fig. 1). The first and second approaches are traditional and mainly applied at households, while controlled fermentation is primarily associated with the fermented food industry and high-scale production. The use of pure starter culture technology ensures process repeatability and contributes to microbial safety of products. For economic reasons, starter cultures must meet a number of requirements, like minimum nutritional needs, rapid growth and acid production, ability to grow at low temperatures, or ability to effectively ferment diverse carbohydrate substrates [4].

✉ Julia Szutowaska  
julia.szutowaska@ue.poznan.pl

<sup>1</sup> Department of Natural Science and Quality Assurance, Institute of Quality Science, Faculty of Commodity Science, Poznań University of Economics and Business, Al. Niepodległości 10, 61-875 Poznań, Poland