



Abstract

Studies on the stability and quality parameters of some probiotic fruit juices incorporated with free and encapsulated *Lactobacilli*

ABSTRACT

The thesis includes a methodical study on the viability and stability of different strains of probiotic *Lactobacilli* and the quality of the probiotic fruit juices developed from litchi, pineapple, guava and orange. The present study determined the potential probiotic strains and suitable carriers for their delivery. The present study also investigated the changes in phytochemical and antioxidant properties of probiotic fortified fruit juices. Optimization of the spray drying conditions for microencapsulation of bacteria was carried out by response surface methodology and physicochemical, morphological properties of the spray dried powders were studied. The viability, stability and cytotoxicity of the spray dried powders and reconstituted fruit juices were also examined. The stability of the optimized product in simulated gastric environment and during storage in refrigerated condition was also evaluated.

The thesis is divided into seven chapters which are briefly discussed below:

Chapter 1 presents the general introduction about probiotics, their classification and types and their health benefits. This chapter also reviews the different benefits of probiotics as functional food ingredients in both humans and animals. It also focuses on functional qualities of the probiotics and food products. Different methods of enhancing the viability of the probiotic bacteria and their stability in different food models are thoroughly discussed. Further, the importance and need to use fruit juices as a vehicle for delivery of probiotics was discussed. The potential of the fruit juice as a carrier and the challenges to develop a probiotic functional fruit juice were also highlighted. It highlights the gap of study and background behind the selection and planning of current investigation. The scope and objectives of the present study are also included.

Chapter 2 studied the probiotic characteristics of the three different strains of *Lactobacilli* and their survivability in freshly prepared juices from four different fruits that are locally

available in Assam. The potential isolates of the *Lactobacilli* and a suitable carrier juice were identified based on the viability of the bacteria, pH, TSS, titrable acidity, and color of the probiotic fruit juices. The viability of the bacterial cells and quality parameters of the probiotic juices were also studied in refrigerated storage condition. The selected strains were also subjected to different biochemical and antibiotic sensitivity tests to confirm their probiotic characters.

Chapter 3 presents a study on the effect of the addition of probiotics on the phytochemical and antioxidant properties of the selected fruit juices. The probiotic juices were analysed for total phenolic content (TPC), total flavonoid content (TFC) and antioxidant properties like DPPH radical scavenging activity, ferric reducing antioxidant property (FRAP). RP-HPLC of the probiotic juices were also carried out to study the changes in the profile of polyphenols, organic acids and sugars during storage. Mineral constituents of the juice were also determined by atomic absorption spectroscopy.

Chapter 4 deals with optimization of spray drying conditions (inlet temperature, feed ratio, and feed rate) for spray drying of *Lactobacillus plantarum* in different fruit juices on the basis of survivability and recovery of the product by response surface methodology. The optimized powders were also analysed for their physical, chemical, morphological parameters.

Chapter 5 includes spray drying of the *Lactobacillus plantarum* in optimized conditions with varied coating material like 15 % (w/v) maltodextrin, 10% (w/v) maltodextrin plus 5% (w/v) pectin, 10% (w/v) maltodextrin plus 5% (w/v) fructose oligosaccharide (FOS) and 5% (w/v) maltodextrin plus 5% (w/v) pectin plus 5% (w/v) fructose oligosaccharide (FOS). The spray dried powders were further analysed for cell viability, stability in fruit juices and other physicochemical and morphological properties and cytotoxicological effect to find out suitable encapsulating materials.

Chapter 6 reports the survivability of spray dried *L. plantarum* MTCC2621 in litchi juice powders on exposure to simulated gastrointestinal environment. The probiotic *L. plantarum* coated with maltodextrin and fructose oligosaccharide (FOS) was tested in simulated gastric juice (SGJ) and simulated intestinal juice (SIJ) for their viability in the *in*

vitro stomach and small intestine conditions. The loss of viability of the encapsulated bacterium during long storage period was also studied.

Chapter 7 presents the conclusions of the work carried out, salient findings and future scope of the present investigation. It is concluded that two strains of *Lactobacillus* viz. *L. plantarum* MTCC2621 and *L. rhamnosus* MTCC1408 are suitable to produce fermented probiotic fruit juices. The viability of the probiotic bacteria was found in desirable numbers up to four weeks in refrigerated condition. The addition of probiotics had both positive and negative effects on the phytochemical and nutritional properties of fruit juices in refrigerated storage condition up to four weeks. The spray drying conditions were also optimized for better viability and stability of the probiotic fruit powder. Inlet temperature had a positive effect on % recovery during spray drying. Fruit juice solid to maltodextrin ratio had a major effect on recovery and survivability of the cells in orange juice and litchi juice model. Flow rate had positive effect on recovery in litchi juice and had negative effect on survivability of the cells in spray dried powders of pineapple juice. Spray drying in optimized condition with maltodextrin plus FOS showed better viability, stability of the powder and longer shelf life than other combinations. The cytotoxicological study revealed that spray dried powders have no toxic effect on human kidney cell lines and thereby are considered as safe. The suitability of specific strain of *Lactobacillus* for developing functional probiotic fruit juice from litchi was determined in this study. This study has provided sufficient information to the existing knowledge on development of a functional probiotic fruit juice and would open up a new dimension in the arena of functional foods with better health benefits.