

Preface

Probiotics have a long history of safe use and have been well-documented for their health benefits on hosts. This volume is a collection of various topics on probiotics, ranging from the microbiological aspects of both prokaryotic and eukaryotic probiotic microorganisms to genetic modifications, maintenance, health benefits and claims, detection, genetic modifications, safety and market trends.

The chapter by Daniel O. Otieno discusses prokaryotic probiotics and their classification based on morphology, ability to form spores, method of energy production, nutritional requirements and reaction to the Gram stain. Prokaryotic probiotics are mainly from the genera of *Lactobacillus* and *Bifidobacterium*. *Lactobacillus* has 106 validly described species, out of which 56 species have probiotic potential. On the other hand, *Bifidobacterium* currently has 30 species validly described, with eight having probiotic capabilities. A close study of these microorganisms revealed that probiotic microorganisms are likely to be Gram positive, mostly rod shaped but with fewer spherically shaped ones, nonspore forming and nonflagellated bacteria.

The chapter by Sukanta K. Nayak covers the microbiological aspects of eukaryotic probiotics. Several eukaryotic microorganisms have been identified with probiotic properties and have been consumed as single cell protein and/or as components of food starters for human and animal consumption. A limited number of these eukaryotic probiotics originate from fungi/moulds/yeasts. Among the eukaryotic probiotics, yeasts especially *Saccharomyces* species are dominant and routinely used in a broad range of hosts. This chapter deals with the occurrence, distribution, taxonomic characterization and detail modes of action of eukaryotic probiotics with special reference to yeasts in human and other animals.

The chapter by Alexander G. Haslberger et al. provides an overview of probiotic strain characterization, gut metagenomics and the analytical methods (FISH, PCR, RAPD, DGGE, repPCR, PFGE, RFLP, microarray, high throughput sequencing) required for their study. Molecular microbiological analysis has increased the understanding of the diversity and phylogeny of beneficial strains and their functions. These modern techniques, including genotyping methods, become increasingly

important for species identification and for the differentiation of probiotic strains. The precise classification and identification of probiotic strains give a strong indication of its typical habitat and origin, safety and technical applicability and provides possibilities for monitoring and product quality.

The chapter by Zhibing Zhang and Benjamin D. Huckle discusses the importance and types of protection techniques for probiotic microorganisms, with a particular focus on encapsulation and compression coating. Beneficial effects of probiotic bacteria depend on the viability of cells once delivered to the intestines. Cells tend to lose their viability with time during storage and the passage through acidic gastric fluids. Enteric coating materials are discussed as suitable for compression coating, while also improving cell storage stability and ensuring cell survival during exposure to harsh acidic gastric fluids. Techniques for controlled release of cells to the colon, including the use of hydrophobic disintegrants such as pectin, are also described.

The chapter by Chathuranga T. Bamunuarachchige et al. addresses the issues of genetically engineered probiotic microorganisms. Improved technologies in genomics and proteomics have led to greater understanding on the beneficial characteristics of probiotics that are enhanced via genetic modification (GM). GM probiotics are mainly associated with improved gut survival and persistence, tolerance of packing and storage conditions and as successful delivery vehicles for therapeutics. These are attributed to increased tolerance to osmolarity, bile salt and reduced water activity. With the expression of various molecules such as antigens, enzymes and molecules of immunological importance within probiotic microbes, the use of GM probiotics in the field of therapeutics looks promising. Safety issues of GM probiotics are also discussed.

The chapter by Wai-Yee Fung et al. documents the strong *in vivo* and *in vitro* evidences of probiotics on gut health, emphasizing on reestablishing the intestinal ecosystem balance, and alleviating gut and malabsorption disorders such as diarrhea, lactose intolerance and irritable bowel syndrome. Probiotics are also therapeutic against postoperative complications and inflammatory bowel diseases, in addition to exerting antibacterial and anticancer properties in the gut, due to their ability to attenuate the immune system. Mechanisms involved include competitive exclusion of pathogenic bacteria for nutrients and adhesion sites, production of antimicrobial bacteriocins and metabolites, and gut immunomodulation.

The chapter by Narayan C. Mandal and Vivekananda Mandal documents the different strains or species of orally consumed probiotics in conferring various new health benefits beyond gut well-being. New roles include modulation of immunological parameters, allergy and lung emphysema. Probiotics fight invading pathogens by various mechanisms, such as competitive inhibition, production of active principles such as bacteriocins, hydrogen peroxide and organic acids. In addition to inhibiting pathogens, probiotics also contribute to improving the immunological and physiological state of the host by interfering with metabolic processes. As they colonize the vital parts of the human intestines, probiotics are intricately involved with different systems of the human body and alleviate the problems associated with them.

The chapter by Siok-Koon Yeo et al. discusses nondairy new carriers for probiotics. Despite being an ideal substrate for probiotics, the growth of probiotics in dairy products is often inhibited by excessive acidification, antagonistic effect of starter cultures and the presence of oxygen during processing. The drawbacks of milk-based carrier associated with cholesterol contents, and lactose intolerance has prompted the development of alternative carriers for probiotics. Currently, soy-based, cereal-based, fruits, vegetables and meat products are developed as potential probiotic carriers. These nondairy products contain reasonable amounts of carbohydrates, fibers, proteins and vitamins that support the growth of probiotics, and protective components that are able to protect probiotics during gut transit, processing and storage. The challenges of these new carriers are also discussed.

The chapter by Maria G. Cifone et al. documents the clinical and experimental evidences of probiotic benefits at the skin. Scientific and evidence-based reports strengthen the assumption that certain probiotics can contribute to modulate cutaneous microflora, lipid barrier, skin immune system, leading to the preservation of skin homeostasis. In this chapter, recent evidences available from scientific literature as well registered patents have been summarized in relation to actual or potential topical applications of probiotics in the field of dermatology. Altogether the evidences reported in this review afford the possibility of designing new strategies based on a topical approach for the prevention and treatment of cutaneous disorders.

The chapter by Istan Siro addresses the challenges of the various probiotic health claims. Substantiation of claims should be based on scientific evidences, which requires a long and expensive procedure. Different *in vitro* and *in vivo* methods are applied for screening and characterizing the putative probiotic strains. Although useful, these assessment tools must be validated by properly designed human clinical studies. Poor prior selection, limited capacity of *in vitro* tests, and unsuitable animal models often contribute to contradictions between *in vitro* findings and *in vivo* feasibility. This chapter reviews the crucial steps of substantiation of health claims associated with probiotics with special emphasis on the related challenges.

The chapter by Fumiaki Abe documents the safety aspects of probiotics, rising from issues including bacterial translocation causing sepsis and horizontal transfer of acquired antibiotic resistance gene. To resolve these concerns, manufacturers have to demonstrate safety of probiotics on a strain by strain basis because not all probiotics are the same. Also, probiotics harboring acquired antibiotic resistance genes should not be used to avoid the possibility of gene transfer. A high hygienic standard to prevent contamination by pathogenic bacteria or allergen during the production of probiotics is another requirement to assure the safety of probiotics. Safety regulation of various countries including the United States, Canada, Australia, New Zealand and Japan are also highlighted.

The chapter by Carlos R. Soccol provides an insight on the current probiotic market trends and future directions. Current trends in the consumption of probiotics are associated with increased levels of health-consciousness, and the availability of probiotics in the form of dietary supplements. Several companies have profited by marketing these products in different forms, with different purposes, and with

recommendation for all ages. Important aspects in maintaining the viability and bioactivity of probiotic strains during processing and storage are also discussed in this chapter. The probiotic consumption by infants and the elderly has been supported by scientific evidences and represents a new niche market.

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