Review: TRENDS IN FERMENTATION TECHNOLOGY: A Nutraceutical approach

**Abstract**

The role of fermentation technology in our lives has been long established right from the age of Egyptians around 5000 B.C.E. Fermentation technology involves harvesting the potential of microorganisms in the form of large-scale production of chemicals, enzymes, proteins, pharmaceuticals and biofuels using right conditions and specific strain of culture to obtain desired results. With further enhancements in the field, humans have been able to utilize a large portion of this technology for their benefit; yet a major chunk remains to be explored that can improve the human civilization in terms of health by manifolds. Continuous efforts and advancements in this field can determine the futuristic trends in Biotechnology which is the broad domain under which this massive potential of a technology resides. A Nutraceutical is defined as any substance that provides medical or health benefits, including the prevention and treatment of disease. Its constituents are either of known therapeutic activity or contribute substantially to the therapeutic activity of a drug. [4] In this review, genetically modified microorganisms as potential to produce desired byproducts has been considered and future trends in nutraceutical industry has been discussed.

Keywords: Nutraceuticals, probiotics, prebiotics, synbiotics, Awareness, Dietary supplements, Functional foods

**Author**

Dr. Moitrayee Maiti

Ph.D Biotechnology

National Centre for Cell Science

Pune

**Introduction**

The famous Hippocrates' quote (400 BC), “Let food be thy medicine and medicine be thy food”, represents that there has been a great interest in herbal products since decades. India has been a hub of Ayurveda and its usage has been carried on since ages. This has been observed in many other civilizations too. The rising global population along with its food requirements and necessity for good nutrition and health awareness has led to conscious shift in improved quality of food production involving better technology and new trends. People are shifting to probiotics, prebiotics and synbiotics[1] in order to ensure better quality of food and shelf life which translates to better health and become disease resistant or develop better immunity. Recent covid pandemic has made people more health conscious. As a result, research and development with respect to nutraceuticals and their mass scale production has gained importance. Popular probiotics in India include Yakult which also happens to be a nutraceutical.[5]

**Probiotics**

Probiotics are live non-pathogenic bacteria used to improve gut health by using external supplementation of bacteria in suspension on capsule form. [12] Probiotics have been considered as an economically safe alternative for the treatment of a large number of chronic diseases and improvement of human health. They are known to modulate the host immunity and protect from several infectious and non-infectious diseases. The colonization, killing of pathogens and induction of host cells are few of the important probiotic attributes which affect several functions of the host. In addition, prebiotics which mainly include fiber, selectively promote the growth of probiotics and human health through nutrient enrichment, and modulation of gut microbiota and immune system. [7]

Figure 1: Potential market of Probiotics in India [11]

**Role of microorganisms as probiotics**

Most commonly used bacteria in probiotic preparations are Lactobacillus, Bifidobacterium, Escherichia, Enterococcus, Bacillus and Streptococcus and yeast like Saccharomyces have also been used. Studies indicate that probiotics are effective in varied clinical conditions- ranging from infantile diarrhea, necrotizing enterocolitis, antibiotic-associated diarrhea, relapsing Clostridium colitis, Helicobacter pylori infections, inflammatory bowel disease to cancer, female uro-genital infection and surgical infections. Lactobacillus rhamnosus strain GG builds intestinal immunity by increasing the number of IgA in the intestinal mucosa. It also stimulates local release of interferons. [8]

**Prebiotics**

The term prebiotics is new which is defined as non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth and activity of one or a limited number of bacteria in the colon for improving the host health. (Gibson and Roberfroid [1995](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8749913/#CR48)).

**Prebiotics Probiotics Synbiotics**

(Dietary fiber) (gut supplements) (mix of and pro)

**IFN-γ**

**Immunity against any disease**

Figure 2: Flowchart of potential role of pre, pro and symbiotic molecules in immune modulation

**Synbiotics**

Synbiotics are combination of pre and probiotics as mentioned in the flow chart above. [8]

**Spirulina**

Spirulina microalgae is of immense nutritional value providing brain health benefits. Innumerous experiments on animals has provided support for the brain health potential of spirulina, highlighting antioxidant, anti-inflammatory, and neuroprotective mechanisms. Some experiments suggest spirulina can help to reduce mental fatigue, protect the vascular wall of brain vessels from endothelial damage and regulate internal pressure, thus contributing to the improvement of cerebrovascular conditions. Spirulina, in malnourished children appears to ameliorate motor, language, and cognitive skills, suggesting a role in development. [6]

Potential of spirulina microalgae as a “superfood” is being tapped by many industries which grow spirulina in large scale and purify to make spirulina tablets. [10]

**Nutraceuticals**

Nutraceuticals are marketed in concentrated forms as pills, capsules, powders either single entity or combination with other products. Nutraceuticals claim to reduce the risk of cancer and heart disease and also prevent or treat hypertension, high cholesterol, excessive weight, osteoporosis, diabetes, arthritis, macular degeneration (leading to irreversible blindness), cataracts, menopausal symptoms, insomnia, diminished memory and concentration, digestive upsets and constipation. Nutraceuticals such as silymarin, curcumin, vitamin E, docosahexaenoic acid, choline and phosphatidylcholine are used as supplements. Many nutraceutical products, such as gallic acid, caffeine, curcumin and others act as anti-aging and antioxidant agents. PUFA1-rich omega-3 fish oils reduce the risk of coronary cardiovascular diseases and enhance the brain functions. Nutraceuticals ingredients, such as epigallocatechin gallate, curcumin, pomegranate and others, treat different types of cancer, such as breast cancer, prostate cancer and other types of cancer. Nutraceutical products provide growth opportunity for the agri-food industry, both domestically and internationally. The potential market is aging population, rising health care costs, advances in food technology and nutrition, as well as a growing consumer understanding of the link between diet and health. [4]

**Types of Nutraceuticals [4]**

**Based on product categories**

* Functional foods e.g. Omega-3, probiotic yoghurt
* Functional beverages e.g. energy drinks, soy beverages
* Dietary supplements e.g. vitamins, minerals

**Based on types**

* Traditional pro and prebiotics
* Non-traditional fortified and recombinant varieties

Nutraceuticals manufacturing companies in India include Dabur India, GlaxoSmithKline, Consumer Healthcare, Cadila Healthcare, Zandu Pharmaceuticals, EID Parrys, Amway, Himalaya Herbal Healthcare, Baidyanath, Pantanjali, Herbalife, Sami Labs Ranbaxy and Elder Pharmaceuticals.

**Disadvantages of probiotics**

Probiotics are live microorganisms, so it is possible that they may result in infection in the host. The risk and morbidity of sepsis due to probiotic bacteria should be weighed against the potential for sepsis due to more pathological bacteria and the morbidity of diseases for which probiotic bacteria are being used as therapeutic agents.

**Nutraceuticals future aspects**

Tapping the health benefits and potential of this field involves selecting right strains by genetically modifying and selection of desired strains. Further studies to make effective targeted delivery of synbiotics to the gut is also a topic for future studies.

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