Best Practice & Research Clinical Gastroenterology 30 (2016) 119–131

Contents lists available at ScienceDirect

Best Practice & Research Clinical Gastroenterology

12

Probiotics, prebiotics and colorectal cancer prevention

Padma Ambalam, PhD, Assistant Professor [a,*],
Maya Raman, PhD, Research Scientist [b],
Ravi Kiran Purama, PhD, Assistant Professor [c],
Mukesh Doble, PhD, Professor [b]

[a] *Department of Biotechnology, Christ College, Rajkot, India*
[b] *Bioengineering and Drug Design Lab, Department of Biotechnology, Bhupat and Jyoti Mehta School of Biosciences and Bioengineering, Indian Institute of Technology, Chennai, India*
[c] *School of Biotechnology, Chemical Building, East Campus, NIT Calicut, Calicut, India*

Keywords:
Colorectal cancer
Gut microbiota
Probiotics
Prebiotics
Synbiotics
Lactobacillus
Bifidobacteria

A B S T R A C T

Colorectal cancer (CRC), the third major cause of mortality among various cancer types in United States, has been increasing in developing countries due to varying diet and dietary habits and occupational hazards. Recent evidences showed that composition of gut microbiota could be associated with the development of CRC and other gut dysbiosis. Modulation of gut microbiota by probiotics and prebiotics, either alone or in combination could positively influence the cross-talk between immune system and microbiota, would be beneficial in preventing inflammation and CRC. In this review, role of probiotics and prebiotics in the prevention of CRC has been discussed. Various epidemiological and experimental studies, specifically gut microbiome research has effectively improved the understanding about the role of probiotics and microbial treatment as anticarcinogenic agents. A few human studies support the beneficial effect of probiotics and prebiotics; hence, comprehensive understanding is urgent to realize the clinical applications of probiotics and prebiotics in CRC prevention.

* Corresponding author.
E-mail address: Padma_ambalam@yahoo.com (P. Ambalam).

http://dx.doi.org/10.1016/j.bpg.2016.02.009

Introduction

Colorectal cancer (CRC) is the third most deadly cancer types reported in United States; and despite the advancements in technology and health awareness program, the prevalence of CRC has been mounting in other developing countries [1]. CRC is a well-defined series of sequences caused by mutations, activations, and deletions of oncogenes and tumour suppressor genes leading to adenoma-carcinoma [2]. Epidemiological, experimental, case, cohort-studies have clearly shown a strong ability of mutagens to induce cancer [3]. CRC is chiefly influenced by environmental factors such as, diet and dietary habits, physical inactivity, consumption of tobacco and other occupational hazards [4]. Food carcinogens produced during cooking at elevated temperatures and air pollution includes, polycyclic aromatic hydrocarbons (PAH), heterocyclic amines (HCA), N-nitroso compounds (NOC), mycotoxins (aflatoxins) and acrylamide that pose as potential risk factors for CRC and other cancer types [5,6]. A metagenome-wide association study on faeces from healthy and advanced adenoma and carcinoma subjects demonstrated that a high intake of red meat compared to fruits and vegetables could be associated with the outgrowth of hostile gut bacteria, and suggested that faecal microbiome-based strategies might be a practical tool for early diagnosis and treatment of colorectal adenoma or carcinoma [7]. Under these circumstances, the antimutagenic agents would play a vital role in reducing the load of mutagens and carcinogens, and maintaining the microenvironment of gut health. Based on their mode of action, these are classified as (i) dysmutagens, to prevent the DNA damage by extracellular modification of the mutagens, and (ii) bioantimutgens, to reduce the mutation rate by direct involvement in the cellular processes [8].

Epidemiological and experimental studies have positively associated the dietary consumption patterns and the prevention of CRC [9–11]. Diet-disease and single nutrient effect in disease prevention has also been demonstrated by other researchers [12]. *In-vivo* results have emphasized the synergistic effects of food and its ingredients and have made the nutrition–health interface more apparent [13]. Therefore, recent studies are focused on identifying the specific food components and their combinations that would offer greater chemopreventive potential, and hence, such functional foods with health benefitting properties are gaining greater attention and popularity [14]. A food supplement principally rich in probiotics, prebiotics and synbiotics could serve as chemopreventive agent in the removal of food-borne mutagens and carcinogens; thus, in the prevention of CRC.

Gut microbiome and CRC

Human microbiota, a pool of microbes, colonizing different parts of body including the gastrointestinal tract, oronasopharyngeal cavity, skin and urogenital tract [15], comprises of approximately 10^{14} bacterial cells that are ten-times higher than the number of cells in the body [16]. In the recent past, this area of research has gained a great attention and has changed the paradigm about the resident microbes and their functions [17]. Development of gut microbiota in an infant is influenced by genetic, epigenetic, environmental factors such as, mode of birth, use of antibiotics and breastfeeding [18]. The delivery mode at childbirth designs the early microbial composition that could subsequently influence the metabolic effects and postnatal maturation of immune system development [19].

Gut dysbiosis that has been associated with the development of chronic diseases including CRC occurs chiefly due to the dominance of pathobionts in the gut [20]. Different animal models such as, genetic knockout, germ-free and chemical mouse models have successfully provided insights to comprehend the link between gut microbes and CRC [21]. Kasai et al. showed that the gut microbiota of normal and cancer patients were different and bacterial groups dominant in the latter were Actinomyces, Atopobium, Fusobacterium, and Haemophilus, implicating that diet and environment play a major role in determining the composition of gut microbiome [22]. Intake of chlorinated water altered the enteric environment by reducing the faecal populations of the obligatory anaerobes *Clostridium perfringens* and species belonging to the Atopobium cluster, including *Enterobacteriaceae* and *Staphylococcus* sp., which were associated with colon tumorigenesis in CPC; Apc mice [23].