Prebiotics in ancient Indian diets

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Gut microflora co-evolved with the human evolution, performing health-promoting functions and protection from the enteric pathogens. The long association of the microflora sustained through ages, which in the light of new research, needs specific nutrients that are not required by the humans. The present article revisits the ancient foods and crops, their availability during different prehistoric times and their contribution in maintaining the gut flora and accrual of the beneficial effects. Although the concept of prebiotics is new, the ancient diet components contained the molecules or precursors of the prebiotics.

Keywords: Ancient diet, enteric pathogens, gut microflora, prebiotics.

PREBIOTICS constitute a well-known class of functional foods. Although the beneficial effect of consuming fermented milk for higher longevity was realized by Bulgarian farmers and revealed by Metchnikoff in 1905, the theory of prebiotics came to light only during the mid-nineties of the previous century[1]. Accordingly, a prebiotic could be defined as 'a non-digestible food ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon'. Some researchers believe that prebiotics are basically carbohydrates possessing shorter chain lengths[2]. Subsequently, the definition of the prebiotic was revised as 'selectively fermented ingredients that allow specific changes, both in the composition and/or activity in the gastrointestinal microflora that confers benefits upon host well-being and health'[3]. Prebiotic oligosaccharides have generated interest amongst food researchers and are getting more and more global attention than other functional foods because of their multipronged beneficial effects, including gut health, higher mineral absorption, lowering of cholesterol, immune system stimulation, pathogen exclusion, etc.[4–6]. Of late, many researchers across the world are engaged in the development of newer prebiotics and trying to unfold their mechanism of action. Systemic information is not available about the consumption of prebiotics or their precursors in the ancient Indian history of civilization. This article attempts to review the prebiotic consumption or accessibility to the ancient Indian population.

During the course of human evolution, prebiotics were consumed through diverse food materials for the well-being and maintenance of good health[7–9]. During the 20th century, one of the major contributions of nutritional science was 'balanced diet' based on the requirement of the essential nutrients. At the turn of the 21st century, the 'balanced diet' remained the key concept, but several additional issues appeared, viz. consumer awareness, food safety, residue problems, quality, designer foods, healthy food, organic foods and so on. Without knowing much about these issues, our ancient Indian population was routinely consuming prebiotics through regular diets, which kept them healthy without any major degenerative diseases.

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Gut microflora

Continued research during the last few decades has revealed that the human gastrointestinal tract houses all forms of life, including bacteria, fungi, archaea, etc. Although the gut of a newborn is sterile at the time of birth, it gradually acquires hoards of microbial population during postnatal life. The establishment of gut microflora is influenced by several factors, including contacts between the child and its environment, mode of delivery, hygiene levels, medication, type of feeding, etc.[10]. It has been often remarked that more than 90% of the total cells of a healthy individual are actually bacterial cells, largely present in the lower part of the gastrointestinal tract[11]. Approximately 10^{14} microbes belonging to more than 500 known species live in a complex, thermostable, nutrient-rich environment and play an important role in host physiology and metabolism[12,13]. Failure to link certain metabolic pathways from the human genome sequence prompted the gut researchers to have a relook at the gut microbiome to explore these supplementary functions. Thereafter, findings of gut microbiome research established that the human chromosomes carry insufficient genes for ensuring proper gut development and immune system, and it completes only after the establishment of gut microflora[13]. Previously, the identification of bacterial

species in the gastrointestinal tract was inadequate because of classical culture-based techniques which generate information for only 10–20% of the population due to its selectivity to facilitate growth and multiplication of specific groups of microbes, leaving aside the vast majority of gut microflora. However, application of 16S rRNA-based molecular tools has allowed the identification of myriads of new species and also of the majority of gastrointestinal bacteria[12,13].

Prebiotics

For proper growth, maintenance and reproduction humans require a number of nutrients, including carbohydrates, proteins, fats, vitamins, minerals, etc. On the road of human civilization, especially during the present century, everybody is concerned more about health and well-being rather than the requirement of nutrients and is eager to eat naturally occurring substances like prebiotics, growth promoters and antioxidants to keep healthy and ensuring a disease-free longer life. Since the introduction of the prebiotics concept, it has attracted much attention, stimulating scientific and industrial interest. As a result, a wide number of prebiotics are researched and available, including fructooligosaccharides (FOS), mannan oligosaccharides (MOS), soya oligosaccharides, xylooligosaccharides (XOS), pectin oligosaccharides, etc.[14].

Ancient Indian civilizations

Civilization means a society that has a complex agricultural and urban culture and is differentiated from other cultures based on social complexity and the varied economic and cultural activities that are an integral part of the society. Therefore, while considering the oldest civilization one should refer to those societies that were developed socially, economically and culturally and not settlements of human beings who primarily lived a nomadic existence. According to the available historical evidences, civilizations started at the Fertile Crescent (Mesopotamia) and then extend to other areas due to a nomadic lifestyle. However, some schools of thought believe that there is no single cradle of civilization, but independent development of civilization occurred in several areas: Mesopotamia (7000 BC), Egypt (10,000 BC), Indus Valley and Shang (9000–5500 BC), and Mesoamerica and Andean South America (5100–1200 BC). The interaction between different communities due to nomadic lifestyles led to the development of common systems and techniques in agriculture, pottery, metal work, etc. Thus it is still a debatable issue and difficult to specifically point out the oldest civilization in the world. Early human settlements were reported to exist in the past Indian territorial regions since 6000 BC. The Indus Valley Civilization comprising twin cities, viz. Harappa and Mohenjo-daro have been reported to exist from 4000 BC with all modern amenities. The different millets, grains and pulses available since the Neolithic period[15] in the Indian region are presented in Table 1. The use of grains in the diet helped the population maintain a healthy gut. Today, it is amply clear that dietary fibre from cereals, millets and pulses beneficially affects the serum cholesterol levels and the digestion process[16]. Due to its beneficial effects on physiology, resistant starch is regarded as a prebiotic among the new generation of dietary fibres[17,18]. Most of the legumes like moth bean, horse gram, black gram, green gram and chick pea have a high non-digestible carbohydrate content (37–48% of carbohydrates)[19]. A reduced starch digestibility in legumes is related to lower glucose release into the blood stream. This would result in reduced postprandial glycaemic and insulinaemic responses with potential beneficial effects in the dietary management of diabetes[7].

Indus Valley Civilization

The oldest Indian civilization that developed along the Indus river valley (Indus Valley Civilization) is currently located in Pakistan. The physical evidences for plant consumption by our ancient Indians are virtually non-existent because of poor preservation of organic plant parts[20]. The Fertile Crescent of southwestern Asia and the Indian subcontinent offered many varieties of wild plants and animals, which were ideal for domestication[21]. Evidences recovered from Mehrgarh suggest that the major cereals during the Indus Valley Civilization included wheat and

Table 1. Agricultural crops in Vindhyan region as revealed by archaeological studies and the prebiotic precursor content

Crop	Available since (Pokharia[15])	Fraction contributing prebiotics action/ prebiotics precursor
Cultivated rice	Neolithic	Arabinoxylan
Hulled barley	Neolithic	Arabinoxylan and glucan
Bread wheat	Neolithic	Arabinoxylan, resistant starch
Dwarf wheat	Neolithic	Arabinoxylan, resistant starch
Ragi millet	Neolithic	Arabinoxylan
Lentil	Neolithic	Resistant starch, galactosides
Field pea	Neolithic	Resistant starch
Chick pea	Neo and Chalcolithic	Resistant starch
Horse gram	Chalcolithic	Resistant starch
Green gram	Neolithic	Resistant starch
Black gram	Neolithic	Resistant starch
Cow pea	Early Iron Age	Resistant starch
Moth bean	Chalcolithic	Resistant starch
Pigeon pea	Neolithic	α-Galactosides
Onion	Early Iron Age	Oligofructose and inulin
Garlic	Late Iron Age (AD 300)	Inulin

barely, in addition to some lentils and tubers. These crops contributed to the resistant starch portion in the diet. Jenkins *et al.*[22] described the health-supporting effects of lentils, similar to those ascribed to resistant starch. Nutritional analysis revealed that wheat crop stores the carbohydrates in the form of fructan (a prebiotic), in addition to its higher content of β-glucan. Historical evidences agree with the point that our Indian ancestors were cultivating these crops which could store their carbohydrate fractions in the form of fructans or inulins. The other food items of Indus Valley population included milk, meat, fish, fruits and dates. Today, we know that milk is one of the important sources of prebiotics, i.e. galactooligosaccharides, which play a major role for maintenance of gut health and function[23]. This substantiates that our ancient Indian population was consuming enough quantity of prebiotics through their routine diets. The present-day scientists are attempting to mimic the similar line of dietary schedules for augmenting gut health and to keep away from the degenerative diseases. Research findings indicated that more than 36,000 plant species store the carbohydrate fractions in the form of inulin or fructans[24].

Vedic Civilization

The Vedic Civilization flourished during 1500–500 BC along the Indo-Gangetic plains characterized by the Indo-Aryan culture that gifted us the great ancient writings, i.e. the four *Vedas*. This civilization was sustained by agriculture. The Vedic period laid the foundation of Hinduism and other cultural aspects of early Indian society. During early periods of this civilization, the society was represented by largely pastoral groups. Honey was one of the auspicious components used in poojas and other rituals. The *Rigveda*, written about 3000 BC, often mentions honey. The Hindus believed that whoever ate honey would become strong, rich, happy and wise, and that it would improve not only his own looks but would influence even his offspring. Honey is of interest as a prebiotic material because it contains many oligosaccharides and low molecular weight polysaccharides. The great Sanskrit Hindu epics, i.e. the *Ramayana* and *Mahabharata* are presumed to be written during this period. Similar to the Indus Valley Civilization, the major crops cultivated by the people of the Vedic Civilization include wheat, barley, rice, cotton, etc. Naturally, some of the above crops are rich in prebiotics for taking care of their gut health and functionality.

Iron Age

The Iron Age of Indian civilization spread during 1200–272 BC also coincided with the Vedic Civilization over a period of time. As the name suggests, people of this period started to use 'iron' by replacing 'bronze' for their routine purposes. A wide range of cereals, vegetables and fruits were cultivated. Milk and milk products were part of their diets and animal husbandry was one of their major activities. Extensive use of ploughing, seed broadcasting, fallowing and application of cow dung for soil improvement were carried out by the people.

The root crop – garlic, presently treated as potential source of the prebiotic 'inulin', is mentioned in all ancient Indian medical literature, i.e. Tibbi, Unani and Ayurveda[25]. Dating to AD 300, the great book of ancient medicine *Charaka Samhita* suggested using garlic for recovery from heart disease, arthritis, stomach disorders, etc.[26]. At that time people did not know the concept of prebiotics, but they were consuming natural foods containing prebiotics for accruing therapeutic benefits. During the course of time, people began to cultivate a wide number of crops such as sugarcane, millets, pepper, various grains, palm, areca, beans, cotton, tamarind and pulses at different places of India.

Conclusion

From the above, it is clear that our ancient Indian populations were consuming foods containing prebiotics through their routine diets. As we know, prebiotic biomolecules are not digested by our own enzyme system; they serve as nutrients to a selective group of gut microflora. The native microflora are stimulated for enhanced growth and multiplication, which imparts beneficial effects on the individual. As a result of increased metabolic products (like acetic acid, lactic acid, etc.), there is lowering of gut pH and blood cholesterol, immune stimulation, pathogen exclusion, increased mineral absorption, etc. During early days of civilization, our ancient population selected crops for cultivation rich in prebiotics after thoroughly considering other features like yield, taste, quality, etc. Unlike European diets, Indian diets include several natural ingredients, especially a variety of grains, fruits and vegetables, which are spontaneously dosing our body with native prebiotics to ensure proper gut health and functionality. The diverse agro-climatic conditions enforce the Indian farmers to grow a number of crops according to soil type, water availability, seed availability, etc. At the same time, the diet profile of the Indian population revealed more consumption of home-made food, cooked in combination with a wide number of plants (especially spices, condiments, onion, garlic, etc.). These are rich in natural prebiotics and antioxidants, unlike processed food in the European dietary style.

The concept of prebiotics development is a recent entry in the functional food science, which benefits human society beyond the nutritional requirement by selective stimulation of gut microflora. The beneficial effects of prebiotics are not only limited to the gastrointestinal ecology, but also exhibit physiological processes like

immune modulation, blood cholesterol regulation, bone mineralization, etc. Therefore, the future of prebiotics depends on how the researchers are able to deliver the specific biomolecules from natural food ingredients economically and unfold their mechanisms of action to benefit the human society.

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