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How can prebiotics and synbiotics be useful to human health

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Abstract
In 21st century we can feel ourselves enough fortunate to learn that most of the people have now been conscious about their health. And, they are aware of the fact that human gut flora plays a key role in maintaining the overall health of an individual. The proper balance between the gut and their microbiota is always required at any cost (Masroor *et al.* 2018). Prebiotics are the food substances which stimulate the growth of useful bacteria naturally inhabitating in our gut. They provide necessary nutrients and shelter for the growth and development of probiotic microorganisms to maintain the health counteracting several diseases. Synbiotics are naturally combining the properties of probiotics as well as prebiotics. These prebiotic foods are easily available in nature. Sometimes, these are also artificially available in market. The only thing is to know them properly. The present paper describes the availability and scope of prebiotics in a very simple language exploring the facts that how it can further be useful to mankind in future. This is a third paper in series of probiotic researches discussing about prebiotics and synbiotics in a nutshell (Masroor *et al.* 2018 and 2019).

Keywords: prebiotics, synbiotics, human health

1. Introduction
Prebiotics were first indentified and named by Marcel Roberfroid and Gibson Roberfroid in 1995 (Gibson *et al.* 1995) [12]. Unlike probiotics, prebiotics are not living organisms. Prebiotics are the food and nutrients that feed probiotics to stimulate probiotic activity in the gastrointestinal tract. Probiotics are fighting a constant battle and need prebiotics from fiber rich foods (among other sources) to stay strong. Prebiotics encourage probiotic colonies to thrive; they also promote general well being. Since, the prebiotic definition does not emphasize a specific bacterial group, it however, assumed that a prebiotic should increase the number and/or activity of *Bifidobacteria* and Lactic Acid Bacteria. A prebiotic may be a fiber, but a fiber is not necessarily a prebiotic. Presently, there are only two most important food ingredients that fulfil the criteria of prebiotics *i.e.* inulin and trans galacto saccharides (Robertfroid 2007) [38]. Inulin belongs to a class of carbohydrates called fructanes. A fractane acts like a prebiotic. In addition to promoting a healthy gastrointestinal tract and reducing constipation, inulin can stimulate bone health by enhancing calcium absorption and lower the rise of atherosclerosis by decreasing blood triglyceride levels (Teuri and Korpela 1998, Kolida *et. al.* 2002, and Silk *et. al.* 2009) [18, 40, 44]. Using probiotics and prebiotics in combination is often described as synbiotic but the United Nations Food and Agriculure Oragnization (FAO) recommends that the term "synbiotic" be used only if the net health benefit is synergistic.

Unlike probiotics, prebiotics are non-digestible fermented food ingredients that stimulate the growth and/or activity of bacteria in the digestive system in ways claimed to be beneficial to health (Table 1 and 2). And, synbiotics refer to nutritional requirements combining probiotics and prebiotics in a form of synergism, hence, symbionts (Table 3). It is believed that a healthy intestinal tract leads to longevity suppress the growth of harmful bacteria and help increase the number of beneficial bacteria in the intestine. They serve as a key role of defence against toxins that invade our body and an appropriate microbial balance in the intestine is crucial for health (Rial 2000, Macfarlane *et. al.* 2006, Quigley 2008 and Rijkers *et. al.* 2010) [20, 35, 36, 37].

2. Materials and Methods
The present paper is prepared on the basis of researches done so far in the field of prebiotics and synbiotics. Several research papers were consulted in order to explore the sources of prebiotic foods with their synbiotic combinations (Table 1, 2 & 3). The paper summarizes the current knowledge on the effects of prebiotics and synbiotics on human health.

Table 1: A list of some prebiotic rich foods

Sr. No.	Foods containing prebiotics	Prebiotic fiber content by weight	Amount of food to achieve 6 g serving of prebiotics
1.	Acacia Gum	85.6 %	7.0 g (0.25 0z)
2.	Raw Chicory Root	64.6 %	9.3 g (0.33 0 z)
3.	Raw Jerusalem Artichoke	31.5 %	19.0 g (0.67 0 z)
4.	Raw Dandelion Greens	24.3 %	24.7 g (0.87 0 z)

5.	Raw Garlic	17.5 %	34.3 g (1.21 0 z)
6.	Raw Leek	11.7 %	51.3 g (1.81 0 z)
7.	Raw Onion	8.6 %	69.8 g (2.46 0 z)
8.	Cooked Onion	5.0 %	120.0 g (4.20 0 z)
9.	Raw Asparagus	5.0 %	120.0 g (4.20 0z)
10.	Raw Wheat bran	5.0 %	120.0 g (4.20 0 z)
11.	Whole Wheat flour cooked	4.8 %	125.0 g (4.40 0 z)
12.	Raw Banana	1.0 %	600.0 g (1.3 lb)

***Source*:** Reproduced from Moshfegh *et al.* 1999 [30]

Table 2: Simple and complex prebiotics

Simple	Complex
Inulin	Pectins
Fructooligosaccharide	Human milk oligosaccharide
Galactooligosaccharide	Resistant Starch
Isomaltooligosaccharide	Resistant Starch
Mannan oligosaccharide	

***Source*:** Reproduced from Park and Floch 2007 [33]

Table 3: Some Synbiotic applications for the human ailments and diseases cured

Sr. No.	Synbiotics	Ailments and diseases cured	Sources
1.	*Lactobacilli* with inulins	Improves the condition of IBS with antimicrobial activity and antisalmonella effect	Mahboubi and Kazempour 2016 and Kanjan and Hongpattarakere 2017 [16, 22]
2.	*Lactobacilli* with fructooligosaccharides (FOS)	Improves the gut microflora and colonic nitrogen-protein metabolism with antitumorigenic activity	Femia *et al.* 2002 and De Preter *et al.* 2007 [10, 11]
3.	*Lactobacilli* with galactosaccharides (GOS)	Improves the fecal microbiota, constipation and IBD	Teuri and Korpella 1998, and Silk *et al.* 2009 [40, 44]
4.	*Bifidobacteria* with inulins	Improves the gut microflora and IBD	Meyer *et al.* 2009 and Mahboubi and Kazem pour 2016 [22, 28]
5.	*Bifidobacteria* with fructooligosaccharides (FOS)	Improves the gut microflora and steatohepatitis	Meyer *et al.* 2009 and Malaguarnera *et al.* 2012 [23, 28]
6.	*Bifidobacteria* with galacto saccharides (GOS)	Improves the fecal microbiota and IBS	Silk *et al.* 2009 [40]
7.	*Bifidobacteria* with trans galactooligosaccharides (TOS)	Improvement in the treatment of colon carcinogenesis	Tanaka *et al.* 2006 [43]
8.	Oligofructose-enriched inulin with *Lactobacillus rhamnosus* GG and *Bifidobacterium lactis* Bb12	Improvement in fecal microbiota and colon cancer with antitumorigenic activity	Femia *et al.* 2002 and Loo *et al.* 2007 [11, 19]

3. Results and Discussion

Currently prebiotics have become very popular as it provides the necessary nutrients to the probiotic bacteria we harbour in our gut to maintain the overall health counteracting several digestive disorders and diseases. The concept of prebiotics came to light during mid-nineties of the twentieth century and is nearly 25 years Old (Gibson *et al*. 1995 and Biplab and Naryan 2014) [2, 12]. Though, probiotics, prebiotics and synbiotics sound similar but are actually different in many ways. These three words gained recognition in early 1900 when Eli Metchnikoff, a Russian Nobel laureate discovered some health benefits regarding the beneficial bacteria found in the gut (Metchnikoff 1907) [27].

Prebiotics are defined as non digestible food ingredients as fibers which stimulate the growth of some useful bacteria naturally inhabiting in our gut. These prebiotics are in fact used as the synonyms to the dietary fibers but not all dietary fibers are always a prebiotic, nevertheless there is a considerable evidence showing that several dietary fibers have prebiotic activity (Paulina and Katarzyna 2017) [34].

The main aim of prebiotics is to stimulate the growth of prebiotic beneficial bacteria in the gastrointestinal tract which confers a health benefit on the host. The majority of prebiotics are carbohydrates having potential prebiotic properties with different molecular structures. These are devoid of any microorganisms but are being treated as a culture media for probiotic bacteria.

Prebiotics occur naturally in a variety of foods like cereal whole grains, fruits, green vegetables and legumes. Some of the sample of foods high in prebiotic fibers are wheat bread, oat meal, barley, wholegrain corn, linseed, soybeans, onion, garlic, asparagus, dandelion greens, Jerusalem artichoke, apples with skin, leeks, tomatoes, potatoes, bananas, berries, psyllium, dried fruits, chicory roots and acacia gums (Mosfegh *et al*. 1999) [30].

Prebiotics are typically found in fibers as an indigestible carbohydrates. It is estimated that about 30g of bacteria are perpetuated for every 100g of carbohydrates fermented. Similarly, the human gut flora is composed of at least 1000 different species of bacteria comprising of the population of approximately $10^{11} – 10^{12}$ cfu/g of contents (Cummings and Macfarlane 1991) [6].

The prebiotic fibers are artificially and chemically identified as inulin, fructooligosaccharides (FOS), galactooligosaccharides (GOS), trans galactooligosaccharides (TOS), lactosucrose, polydextrose, cyclodextrins and malt oligosaccharides (MOS). Some other non starchy prebiotic polysaccharides are cellulose, hemicellulose and pectins (Park and Floch 2007) [33].

Basically two types named as soluble and non-soluble dietary fibers are found in nature. While soluble fibers are used to lower the serum lipids, the non-soluble dietary fibers of plant origin have been usually linked with normal laxation that increases the stool weight via fermentation. It may help in reducing the transit time via increase in the ease of defecation, which ultimately gives relieve in constipation to solve the problems of evacuation disorder and irritable bowel syndrome (Cummings 1993, Madden and Hunter 2002 and Slavin 2013) [5, 21, 41].

It has been reported that prebiotics have the ability to alter the gut microflora depending upon the type of prebiotic foods containing fermentable fibers, environment and pH of the alimentary canal. These prebiotic fibers are fermented in colon improving the immune and bowel function of an individual. (Van *et al*. 2005) [45]. They go through small intestine undigested and reaches the colon in an unaltered form. They are also resistant to the effect of stomach acids, proteases and even bile salts (Biplab and Narayan 2014) [2].

Prebiotic diets mostly containing inulin and oligofructose have been found as the best medium for the culture of good bacteria like *Bifidobacteria, Lactobacilli* and others providing a variety of health benefits to the host. They cause a reduction of intestinal pH and maintain the osmotic retention of water in the bowel. It reduces the constipation naturally (Crittenden and playne 2009) [4]. It also increases the ability of an individual to absorb calcium and magnesium (Demigne *et al.* 2008 and De Preter *et al.* 2011) [8, 9].

It also appears that those who are taking vegetables and fruits regularly are less commonly suffering from hepatic disorders and colorectal carcinoma (Daubioul *et al.* 2005 and Munjal *et al.* 2009) [7, 31]. These prebiotics are able to reduce blood LDL and triglycerol levels and dental carries (Jakubczyk and Kosikowska 2000 and Mojka 2014) [29]. It prevents peptic ulcers and vaginal mycosis (Socha *et al.* 2002) [42]. It also inhibits the growth of undesirable bacteria like *Salmonella* infections and reduces the incidence of nosocomial infections (Asahara *et al.* 2001) [1].

Further, synbiotics are also found as foods containing both probiotics and prebiotics in a synergistic relationship. They are naturally combining the properties of probiotics and prebiotics. It is experienced that probiotic bacteria reproduce well and lives longer if synbiotics are applied. The synbiotic combination of both components showed, better results as compared to either probiotics or prebiotics alone (Gibson *et al.* 1995 & 2004, Bouhnik *et al.* 2007 and Kiray and Kariptas 2015) [3, 12, 13, 17].

The best known synbiotic combinations reported so far are as *Lactobacilli* with inulins, *Bifidobacteria* with inulins, *Lactobacilli* with fructooligosaccharides (FOS), *Lactobacilli* with galactooligosaccharides (GOS), *Bifidobacteria* with fructooligosaccharides (FOS) and *Bifidobacteria* with galactooligosaccharides (GOS) (Gulmez and Guven 2002, Olveira and Gonzalez 2016) [14, 32]. The most common application of these combinations has been the *Bifidobacteria* with oligosaccharides (Yerlikaya and Kargozlu 2009) [46]. Though, the positive effects of synbiotics for metabolic health in human is still unclear, their applications for the modulation of gut and fecal microbiota seems promising (De Preter *et al.* 2007, Silk *et al*. 2009, Scavuzzi *et al*. 2014, Malaguarnera *et al*. 2012, Masroor *et al.* 2015, 2018 & 2019, Mahboubi and Kazempour 2016 and Kanjan and Hongpattarakere 2017) [10, 16, 22, 23, 24, 25, 26, 39, 40].

Lastly, since the human gut microflora of an individual is as distinctive as fingerprints and has often been influenced by the lifestyle, diet and diseases, antibiotics intake, age and socioeconomic conditions and even stress and thinking, their harmony and homeostasis must be maintained at any cost (Masroor *et al.* 2015, 2018 & 2019).

4. Conclusion

Prebiotics are food substances made of fibers on which probiotic good bacteria grew to stimulate the activities of human gastrointestinal tract. Though, these prebiotic good foods are being used up by the human society unknowingly for centuries, only recently their scope and importance have been recognized in literature. They are in fact, made of a variety of fibers, but it does not necessarily mean that every fiber is a prebiotic. Prebiotics are useful, non living and indigestible part of a food encouraging the growth of probiotic good bacteria residing in the human gastrointestinal tract. Further, as probiotic flora of good bacteria are continuously and comprehensively getting disturbed due to altered lifestyle and nutrition, people have currently been suffering from ailments, disorders and diseases vividly. In addition, a new word called as synbiotics has also been popularizing where probiotics are mixed in combination with prebiotics. Conclusively, the paper is about the study of prebiotics and synbiotics scrambling as to how they can be useful to mankind in future.

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6. Conflict of Interest

The authors have declared no conflict of interest. They have approved the final version of the manuscript contributing equally.

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