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The Beneficial Effects of Onions on Gut Health: A Review

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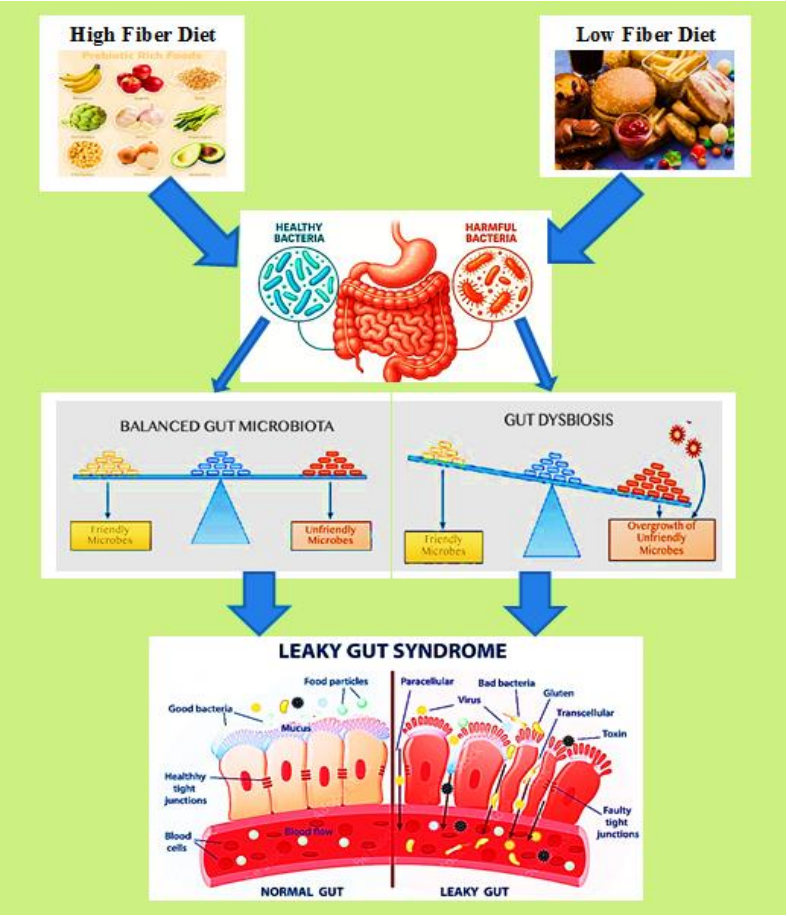
Abstract: Onion (*Allium cepa L.)* is a common vegetable that contains fiber known as fructans, a type of soluble carbohydrate that acts as a prebiotic, fermented by intestinal bacteria, which output short-chain fatty acids (SCFAs). Fructans, a type of soluble carbohydrate, act as a prebiotic, meaning they feed the beneficial bacteria in your gut. Fermenting onions promotes antioxidant activity and raises the availability of bioactive compounds like flavonoids and SCFAs. This review underscores the benefits of a high-fiber diet, such as onions, which increases beneficial bacteria in the gut and reduces harmful bacteria. This contributes to a balanced gut microbiome homeostasis; the balanced pH in the intestine helps maintain healthy immune cells, minimizes the risk of certain diseases, and enhances overall gut health. In contrast, diets containing processed foods and low in fiber reduce beneficial bacteria, leading to an imbalance of bacteria in the gut (dysbiosis); the pH turn into unbalanced, more permeable of the intestinal barrier, leading to a status called "leaky gut," in which toxins, bacteria, and undigested food particles leak into the bloodstream, making you more susceptible to disease. Finally, we suggest replacing low-fiber foods with high-fiber ones, as well as avoiding sugars, preservatives, and processed foods, as these positively impact the health and vitality of the gut microbiome. This is an effective approach to maintaining the society of microorganisms that live in the intestines. and play a vital role in digestion, immunity, and many other body processes, thus maintaining gut health. It plays a vital role in the digestive process.

Graphical Abstract



Keywords: Onion, Prebiotic, Gut Microbiota, SCFAs, Gut Health

Introduction

Onions (*Allium cepa L.*) are a popular vegetable known for their nutritional and health benefits [1]. Onions are a good source of vitamins, minerals, and fiber and are known to offer a variety of health benefits. Onions contain bioactive compounds such as polyphenols, most notably quercetin, which have antioxidant, anti-inflammatory, and antibacterial properties [2]. Studies have shown that quercetin helps inhibit lipid peroxidation, inhibit the initial inflammatory process, and improve the immune system [3]. The other health benefits of onions include their role in preventing obesity, diabetes, cancer, allergies, cardiovascular, neurological, and respiratory diseases [4], [5].

Maintaining a highly acidic environment in the stomach helps kill most bacteria that enter the stomach with food [6], in addition to activating digestive enzymes necessary for breaking down proteins into smaller molecules, such as pepsin. Conversely, an alkaline environment will hinder the activation of this enzyme, leading to incomplete digestion and decreased absorption of nutrients [7]. Most ingested proteins are first digested by pepsin in the stomach, which produces from them polypeptides, peptides, and free amino acids [8]. In the small intestine, the acidity level is reduced by certain secretions from the pancreas and bile, which significantly contribute to enzyme activation [9]. Therefore, a low alkaline pH assists in neutralizing stomach acid and promotes the enzymes' optimal performance, responsible for the digestion of proteins, carbohydrates, and fats. A balanced pH level in the small intestine guarantees food breakdown completely and the absorption of vitamins and minerals, such as Ca, Fe, and Vit B12 [10].

Diet plays a critical role in maintaining a healthy intestinal pH balance, with dietary fiber being one of the essential nutrients. Intestinal bacteria ferment fiber in the colon, resulting in short-chain fatty acids (SCFAs). These acids help lower the pH of the large intestine and promote the growth of beneficial bacteria. SCFAs, especially butyrate, are important substances for gut health, as they reduce inflammation and strengthen the intestinal barrier, contributing to overall digestive health [11], [12], [13]. Foods rich in fiber, whether soluble or insoluble, are essential for gut and digestive health. Soluble fiber, found in barley, oats, beans, lentils, apples, berries, carrots, and broccoli, helps regulate pH levels and promote gut health [14]. Insoluble fiber, existing in whole grains, leafy greens, and seeds, contributes to regular bowel movements and supports digestive health [15].

Prebiotics are indigestible fibers that feed the beneficial bacteria in the intestine. Prebiotic-rich foods, such as onions, garlic, leeks, asparagus, apples, bananas, and chicory root, help promote the growth of these beneficial bacteria, boost the production of SCFAs, and improve overall gut health [11], [16], [17]. The main fiber in onions is fructans, a type of soluble carbohydrate that acts as a prebiotic, meaning it feeds the beneficial bacteria in your gut, although it can cause digestive problems in some people. Onions are rich in antioxidants such as flavonoids and quercetin, which play a role in disease prevention. Fermenting onions promotes antioxidant activity and contributes to increasing the availability of these bioactive compounds, such as flavonoids and SCFAs, which promote gut health and various body functions [18], [19]. Most studies have shown that a diet rich in fermented foods increases microbiome diversity and reduces inflammatory signals and activity [20]. Wherefore, fermenting onions may decrease their FODMAP properties and improve symptoms of inflammatory bowel disease [20]. Finally, onions feed the beneficial bacteria in the gut, which may promote colon health and lower the risk of certain diseases.

pH affects the gut homeostasis, leading to changes in the composition and activity of the gut microbiota through the presence or absence of certain types of microbes, leading to bacterial imbalance. These microbes are essential for digestion, absorption, immunity, and overall health. The intestinal microbiome flourishes in an environment that ranges from neutral to acidic, and any considerable change in pH can disrupt this accurate balance [21]. The slightly low pH of the large intestine stimulates the growth of beneficial bacteria that result in SCFAs from the fermentation of fiber, like *lactobacilli* and *bifidobacteria*. These SCFAs are primary for gut health because they are the primary source of energy for colon cells, contribute to reduced inflammation in the gut, and assist in maintaining the integrity of the intestinal lining and block harmful substances from leaking into the bloodstream [22]. When the optimal pH of the large intestine is abnormal, it can affect the balance of intestinal bacteria, potentially leading to health problems like obesity, ulcerative colitis, inflammatory bowel disease (IBD), and

irritable bowel syndrome (IBS). Overall, SCFAs offer a range of benefits for gut health and are essential for maintaining gut bacterial balance and bowel function [22], [23]. Thus, maintaining a stable pH maintains gut homeostasis and prevents dysbiosis.

A diet high in processed foods and sugars is detrimental to gut health, while a diet rich in whole foods promotes a healthy gut microbiome. Processed foods, refined carbohydrates, and added sugars can all feed harmful bacteria in the gut [24], increasing their numbers at the expense of beneficial bacteria and thus negatively impacting gut pH and bacterial balance. This detrimental effect is to boost the growth of harmful bacteria, leading to an imbalance in the microbiome and potentially a more alkaline environment, and disrupting the production of SCFAs [25]. This shift in the balance between beneficial and harmful bacteria can lead to many health problems, involving inflammation and increased intestinal permeability.

The intestine is considered the body's "largest immune organ," housing a large percentage of immune cells. The intestine plays a vital role in the immune system, containing a large percentage of immune cells. The intestine is home to 70-80% of the immune cells found in gut-associated lymphoid tissue (GALT), which protects the body from pathogens [26]. This tissue forms a network of lymphoid cells and tissues that reside in the intestine and is the first line of defense against pathogens that enter the body through food and drink. The pH of the intestine plays a role in regulating these immune responses. The acidic environment in the stomach aids in destroying pathogens, while the balanced pH in the intestine supports the maintenance of healthy immune cells and an effective immune response [21]. An imbalance in the intestinal pH disrupts the intestinal microbiome, which can affect immune system function and raise the risk of infection, allergies, and autoimmune diseases [21]. The intestinal pH level also affects the integrity of the intestinal barrier, a protective layer of cells that prevents harmful substances from entering the body. When the pH is unbalanced, the intestinal barrier may be more permeable, leading to a state called “leaky gut,” in which bacteria, toxins, and undigested food particles leak into the bloodstream [27], [28]. This leakage can trigger general inflammation and is linked to chronic health problems, involving food allergies, mental health disorders, and autoimmune diseases.

Conclusion

Eating foods rich in fiber enhances the growth of beneficial bacteria in the intestinal tract and assists in maintaining bacterial balance (Microbiota homeostasis). On the other hand, excessive consumption of sugars, fats, and processed foods reduces beneficial bacteria and increases harmful bacteria, leading to intestinal imbalance. When beneficial bacteria feed on fiber-rich foods such as onions, garlic, chicory, soybeans, and bananas, they produce SCFAs, such as butyrate, which have various health benefits, including reducing inflammation and improving gut health. When beneficial bacteria don't get enough fiber, or when they consume sugary and processed foods, such as sweets, soft drinks, fast foods, packaged foods, and packaged snacks, they contain high amounts of sugar and fat, which are food for harmful bacteria. Consequently, the number of beneficial bacteria may decrease, allowing harmful bacteria to multiply. This leads to an imbalance in the microbiome (Dysbiosis), with fewer beneficial bacteria and more harmful bacteria, which can cause various health problems. When harmful bacteria feed on these foods, they produce toxins that can harm intestinal health and cause inflammation.

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