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Potential health benefits of Onion (Allium cepa), Garlic (Allium sativum) and Turmeric (Curcuma) as prebiotics.

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ABSTRACT

The human gut microbiota is involved in a cascade of activities needed for body health. Their imbalance can cause serious metabolic anomalies and a wide range of illnesses. Prebiotics have become a popular non-pharmacological strategy for restoring intestinal symbiosis and enhancing wellbeing. Prebiotics are non-digestible fibres that provide sustenance to the intestinal bacteria. This review summarizes the potential health benefits of Onion (*Allium cepa*), Garlic (*Allium sativum*) and Turmeric (*Curcuma*) as prebiotics. Researchers have been reported that Garlic has traditionally been known to provide a variety of health benefits, including the avoidance of gastrointestinal illnesses. Studies on the prebiotic effects of garlic fructan (GF) on the microbiota of the human stomach were conducted. In addition to their antimicrobial, cell-reinforcing, anticarcinogenic, antimutagenic, anti-asthmatic, immunomodulatory, and prebiotic properties, onion extracts have been shown to be effective in the treatment of cardiovascular disease due to their hypocholesterolaemia, hypolipidaemia, against hypertensive, hostile to diabetic, antithrombotic, and against hyperhomocysteinemia impacts. Turmeric Extract's high phenolic and carbohydrate content, as well as its resistance to gastrointestinal enzymes, have led some researchers to believe that it could be used as a prebiotic in real food. The current review work is a complete and up-to-date compilation of the existing works on prebiotic properties of Onion, Garlic, and Turmeric.

Keywords: *Allium cepa, Allium sativum,* anti-hyperhomocysteinemia, antimicrobial, antioxidant, *Curcuma*, hypocholesterolaemia, prebiotics.

RESUMEN

La microbiota intestinal humana participa en una cascada de actividades necesarias para la salud del cuerpo. Su desequilibrio puede provocar graves anomalías metabólicas y una amplia gama de enfermedades. Los prebióticos se han convertido en una estrategia no farmacológica popular para restaurar la simbiosis intestinal y mejorar el bienestar. Los prebióticos son fibras no digeribles que proporcionan sustento a las bacterias intestinales. Esta revisión resume los posibles beneficios para la salud de la cebolla (Allium cepa), el ajo (Allium sativum) y la cúrcuma (Curcuma) como prebióticos. Se ha informado a los investigadores que tradicionalmente se sabe que el ajo proporciona una variedad de beneficios para la salud, incluida la prevención de enfermedades gastrointestinales. Se realizaron estudios sobre los efectos prebióticos del fructano de ajo (GF) en la microbiota del estómago humano. Además de sus propiedades antimicrobianas, reforzadoras de células, anticancerígenas, antimutagénicas, antiasmáticas, inmunomoduladoras y prebióticas, los extractos de cebolla han demostrado ser eficaces en el tratamiento de enfermedades cardiovasculares debido a su hipocolesterolemia, hipolipidemia, contra la hipertensión, hostiles a Impactos diabéticos, antitrombóticos y contra la hiperhomocisteinemia. El alto contenido fenólico y de carbohidratos del extracto de cúrcuma, así como su resistencia a las enzimas gastrointestinales, han llevado a algunos investigadores a creer que podría usarse como prebiótico en alimentos reales. El presente trabajo de revisión es una recopilación completa y actualizada de los trabajos existentes sobre las propiedades prebióticas de la cebolla, el ajo y la cúrcuma.

Palabras clave: Allium cepa, Allium sativum, antihiperhomocisteinemia, antimicrobiano, antioxidante, cúrcuma, hipocolesterolemia, prebióticos.

INTRODUCTION

Prebiotics and their potential health benefit: Prebiotics, including poly and oligosaccharides, resistant starches, sugar polyols, and fiber, are non-digestible carbohydrate (CHO) molecules necessary for healthy gut flora and growth. Prebiotics have been shown to increase the metabolic activity of the beneficial bacteria already present in the gastrointestinal tract (GIT), which may have beneficial effects on digestion, absorption of nutrients, and immunity. (Lockyer and Stanner, 2019). These substantial advancements suggest that they have a positive impact on human health (Mohr *et al.,* 2020). Prebiotics are a great food component for promoting the development of beneficial stomach organisms that age them, resulting in the production of postbiotics like short-chain unsaturated fats (SCFAs), nutrients, and other divided atoms because they can survive in acidic conditions and remain resistant to explicit stomach related proteins in the small intestine. (Yadav and Jha, 2019).

“There are several plant foods that include prebiotics, such as chicory, chia seeds, dandelion greens, flaxseeds, onion, garlic, almonds, artichoke, oats, barley, and many more”; prebiotics may also be produced by the enzymatic breakdown of complex polysaccharides. (Davani-Davari *et al.,* 2019). “Fructooligosaccharides (FOS), guar gum, galactooligosaccharides (GOS), and inulin are all examples” of naturally occurring prebiotics that are now on the market, whereas hydrolyzed xylan oligosaccharides (XOS) are still in the research and development phase.

The concept of prebiotics: The term "prebiotics" has changed dramatically during the last few decades. Prebiotics were first defined in 1995 as "non-digestible food elements that have favourable effects on the host by selectively encouraging the growth and multiplication of one or specific bacteria in the colon, resulting in significant improvements in the host's health" (Gibson, 2008). Prebiotics were once understood to be synthetic compounds that promoted the growth of bacteria; in particular, Bifidobacteria and Lactobacilli. However, the definition was revised in 2004 to include "specifically aged substances that work on the action and piece of gastrointestinal microflora and carry benefits to have wellbeing and prosperity." It is proposed here that prebiotics are resistant to digestion and are broken down by the vegetation in the stomach. "(Gibson et al., 2004)" In light of advances in atomic methodologies and total proof about the depth and variety of bacterial networks, the Global Logical Relationship for Probiotics and Prebiotics (ISAPP) reformulated the meaning of dietary prebiotic in 2010. They defined it as "a specifically matured fixing that outcomes in unambiguous changes in the piece and action of the gastrointestinal microbiota, thus giving advantage (s)" (Gibson et al., 2010). This revised definition expands the range of bacterial species to include those found throughout the gastrointestinal tract, not only the colon.However, Bindels *et al.* (2015) provided a definition of prebiotics as "non-digestible substances that modify the composition and/or activity of the gut microbiota through metabolization by bacteria in the gut, therefore conferring a favourable physiological effect on the host." Prebiotic interactions with gut microbiota that do not include extra-intestinal habitats like the respiratory system, vagina, or skin are now included in this definition, which previously required selective fermentation processes or microbial specialization. (Bindels *et al.,* 2015). In 2017, ISAPP modified the prebiotic notion again, defining it as "a substrate, i.e., specifically utilised by host microbes and delivering a health benefit (s) to the host while keeping the microflora-mediated health advantages." Animals, in addition to humans, may now be considered to benefit from prebiotics since the term's expanded meaning no longer excludes non-food components or extra-intestinal tissues in addition to carbohydrates and foods. (Gibson, 2012).

“The most popular prebiotics at the moment are non-digestible carbohydrates including FOS, GOS, inulin, and lactulose (Yang *et al.,* 2019; Zeng *et al.,* 2019; Xavier-Santos *et al.,* 2019; dos Santos *et al.,* 2019). Other non-digestible carbohydrates with prebiotic potential include arabinoxylan, beta-glucans, isomalto-oligosaccharides (IMO), polydextrose, soybean oligosaccharides, XOS, and xylo-polysaccharide (XPS), according to clinical evidence (Xavier-Santos *et al.,* 2020), Although the majority of the scientific literature on prebiotic potential is focused on FOS and inulin (Martinez).

Prebiotics and Dietary Fibre: Prebiotics are fibers found in food that provide nourishment for the good bacteria already present in the human digestive tract. (Davani-Davari *et al.,* 2019; Shortt *et al.,* 2018). Although several types of dietary fiber have been categorized as prebiotic, this is not always the case. It was not until 1953 that the name "dietary fiber" was coined, although the health advantages of fiber (such as increased stool weight, laxative effects, and disease prevention) were already well-known. (Slavin, 2013). Both the ADA and the FDA classified fibers into two categories in 2008. There are two types of fiber, dietary fiber (composed of lignin and other non-digestible carbohydrates and found whole in plants) and functional fiber (isolated from such carbs and having beneficial effects on humans). (King *et al.,* 2012). Incorporating the FDA's definition of dietary fibers into food processing and labeling is a priority. According to this definition, dietary fibers are "synthetic or isolated carbohydrates having three or more monomeric units that have a favorable physiological impact on human health." (González-Vallejo and Lavins, 2016). One of the most important functions of dietary fibers nowadays is in the prevention of metabolic (cancer, diabetes, and obesity) and cardiovascular (CVD) illnesses. (Slavin, 2013). However, the term "dietary fibers" does not have a unified definition and has diverse connotations in various parts of the globe. (Guarino *et al.,* 2020).

"After the Codex Alimentarius Commission established the concept of dietary fiber in 2009, the Ninth Vahouny Fibre Symposium refined it in 2010. (Howlett *et al.,* 2010), Dietary fibers were defined as non-digestible carbohydrates with a polymerization degree in the 3-9 range." It was claimed that they improved health by doing things like decreasing intestinal transit, increasing stool size, and promoting microbial fermentability, all while lowering blood glucose and cholesterol levels. (Howlett *et al.,* 2010). Edible carbohydrate polymers are described as carbohydrate polymers (10 or more monomeric units) that are not hydrolyzable by endogenous enzymes and occur naturally in food, and were added to the Codex Alimentarius Commission's definition of dietary fibers in 2017. Carbohydrate polymers, on the other hand, are polymers made from natural food sources by chemical, enzymatic, or physical processes, and they are credited with providing health benefits. Scientific data obtained by authoritative bodies demonstrates that synthetic carbohydrate polymers, a kind of polymer that can be synthesized chemically, also have beneficial physiological effects on human health. (Rayner *et al.,* 2013).

Soluble fiber and insoluble fiber are the two main categories of dietary fiber. Studies have shown that soluble fiber improves blood lipids but insoluble fiber increases constipation and stool weight. "Additionally, fibers are classified based on their fermentability and viscosity; fermentable fibers are those that are rapidly digested by bacteria, while viscous fibers create a gel in the GIT. It is important to remember that there is no universally agreed-upon way to categorize fibers. (Slavin, 2013). Soluble maize fiber, guar gum, and Arabic gum are all examples of highly fermentable dietary fibers. These are rapidly fermented in the intestines and are beneficial to health." Cellulose, for example, is a poorly fermented fibre that provides roughage but none of the prebiotic benefits. (Dayib *et al.,* 2020; Swanson *et al.,* 2020). Arabic gum is made up of primarily arabinose and galactose, along with certain glycoproteins, although there are contradictory claims about its health benefits. (Dashtdar and Kardi, 2018). "Hydrolysates of guar seeds rich in the water-soluble galactomannan make up the bulk of partly hydrolyzed guar gum.

Human endogenous enzymes are unable to cleave the glycosidic bonds found in polysaccharides such cellulose, lignin, hemicellulose, pectin, and mucilage.The difference between prebiotics and dietary fibers lies mostly in this regard." These polysaccharides are not broken down by the body's own enzymes, but rather undergo partial fermentation in the gut. (Lo Presti *et al.,* 2019). Few dietary fibres provide health benefits because they increase the activity and proliferation of gut bacteria that may be linked to happiness and health, thereby serving as prebiotics (Roberfroid *et al.,* 2010).

It is now beyond dispute that dietary fiber may modify the composition of gut bacteria. It is also well known that switching from a meat-based diet to one high in fiber (>30 g /day) encourages a shift in bacterial diversity and the synthesis of fermented products, but not by enough to be labeled prebiotic. Therefore, it follows that consuming more fiber aids in maintaining the favorable benefits. This has been shown by a group of researchers (Den Besten et al., 2013). According to the study by Hiel and colleagues, Bifidobacterium and Clostridiales levels in the gut were significantly raised after three weeks of eating a diet rich in inulin-rich vegetables. It has been shown that.(Hiel et al., 2019). Dietary fiber's physical and chemical properties determine which microorganisms may utilize and ferment it. Chemically complex dietary fibers, such as those with many connections, sugars, and branching patterns, need the concerted efforts of microbial enzymes for full digestion. The greater the intricacy of food fibers, the fewer gut microorganisms can break them down. For instance, many species of Bacteroides can grow when given glucose and xylose, but only a select few can do so when given xyloglucans. (Cantu-Jungles *et al.,* 2020).

The cheap cost and high potential health advantages of prebiotics have piqued the curiosity of several pharmaceutical manufacturers. (Khangwal and Shukla, 2019). High-quality prebiotics are now most often synthesized by enzymatic digestion. However, different microbes use prebiotics in different ways because different gut bacteria have different dietary requirements. Prebiotics are very important in the digestive system because they provide the bacteria that dwell there with the fuel they need to survive, multiply, and carry out their many metabolic functions. (Rolim, 2015), As a result, they've been widely used in the food industry as functional dietary supplements in a variety of forms (Al-Sheraji *et al.,* 2013). In this regard, this review will discuss about the potential health benefits of Onion (*Allium cepa*), Garlic (*Allium sativum*) and Turmeric (*Curcuma*) as prebiotics.

POTENTIAL HEALTH BENEFITS OF ONION, GARLIC AND TURMERIC AS PREBIOTICS

Onion as prebiotics: In our cuisine, the onion (Allium cepa) is a common ingredient. Onion extracts have been shown to be effective in treating cardiovascular disease due to their antimicrobial, cell-reinforcing, anticarcinogenic, antimutagenic, anti-asthmatic, immunomodulatory, and prebiotic properties as well as their hypocholesterolaemia, hypolipidaemia, hostile to hypertensive, against diabetic, antithrombotic, and against hyperhomocysteinemia effects. Given the significance of these veggies and targeted supplements for both preventative and curative reasons, this study analyzes the key natural activities of each, along with the synthetics responsible for each. Furthermore, the impact of processing on bioactivity, as well as adverse effects and interactions with other drugs, have been studied (Zaki *et al.,* 2022).

Potential health benefits of onion as prebiotics: "Several studies have found that onions' biological and medicinal functions are mostly owing to their high amount of organo-sulphur compounds (Augusti and Mathew, 1974). S-alk(en)yl-L-cysteine sulphoxides (ACSOs), including allicin and g-glutamylcysteines, are synthesized from different metabolic routes in each vegetable and serve as both biosynthetic precursors and important storage peptides. The chemical dialyl is a sulfate that may dissolve in fats. (Lancaster and Shaw, 1989). These chemicals give onions their distinct smell and flavour, as well as the majority of their biological functions (Lanzotti, 2006)."

Oligosaccharide Content of Onion: The categorization of oligosaccharides is not set in stone, even when utilizing cutting-edge execution fluid chromatography (HPLC). Method AOAC 2001.02 was used to analyze galactooligosaccharides (GOS) and raffinoses, whereas method AOAC 997.08 was used to analyze inulins and fructooligosaccharides (FOS). We utilized a gel TSK Amido-8 section (4.6 250 mm, Tosoh, Tokyo, Japan) and LC-10ADVP siphons to infuse 20 L of test material (Shimadzu, Kyoto, Japan). The section was found using a Refractive List and the temperature was 35 degrees Celsius (RI). The portable acetonitrile and water stage has a flow rate of 1 mL/min (proportion 80:20). Taking a glance at the top of the normal curve leading to the sugar fixation in the example reveals that the sugar obsession is not fixed in stone. (Munaeni *et al.,* 2021).

Use of Buton Forest Onion Extract (BFOE) to Stimulate Probiotic Growth: Through the use of spectrophotometric methods, the function of BFOE in promoting probiotic development was studied. Huebner *et al.* (2008) tweaked somewhat to fit the context. Each concentration of BFOE was measured in triplicate after being diluted in sterile distilled water at a concentration of 10, 5, 2.5, 1.25, 0.625, 0.313, and 0.156 mg/mL (b/v). Ten milliliters of Sea Water Complete medium was added to each of three different concentrations of BFOE, whereas the medium alone was used in the control. This is Bacillus sp. and P. piscicida 1Ub. Bacterial suspension NP5 was cultivated in liquid Sea Water Complete medium at 140 rpm for 18 hours, whereas V. parahaemolyticus was cultured for 14 hours. An inoculum of 5% (v/v) of a bacterial suspension (108 CFU/mL) was added to each treatment, which was then incubated at 28-29 degrees C at 140 rpm. We utilized a UV-200-RS spectrophotometer to detect the OD600 of the supernatant at 600 nm; in the absence of bacteria, we used liquid Sea Water Complete media. Fourteen, eighteen, and twenty-four hours of BFOE's impact in stimulating probiotic development were analyzed. Medium devoid of microorganisms was used to make the blanks. (Huebner *et al.,* 2008).

Garlic as prebiotics: Garlic has long been thought to provide a variety of health benefits, including the avoidance of gastrointestinal illnesses. Garlic fructan (GF), one of the main components, was tested for its prebiotic effects on human gut microbiota (Melguizo-Rodríguez *et al*., 2022).

Garlic's diverse components appear to have contradictory effects on the gut microbiome. Fructans serve as prebiotics for the gut flora, according to experiments with isolated components (Peshev *et al.,* 2014).

Garlic contains allicin and other sulphur compounds that have antimicrobial properties (Murat *et al.,* 2017). Garlic may be effective against both Gram-negative and Gram-positive bacteria due to its antibacterial characteristics. (Atsamnia *et al.,* 2017). *In vitro studies have shown that garlic's antibacterial properties are particularly effective against Staphylococcus aureus, Mycobacterium tuberculosis, and Proteus species.* (Ibrahim, 2017). Studies have shown that using garlic as a natural prebiotic in feed at a concentration of 1% may improve growth rates. (Adebiyi *et al.,* 2017).

Prayogi Sunu *et al.* (2019) found that the most effective dose of extract to boost L was 4 milliliters. acidophilus, feed viability, temperature resistance, feed storage duration, and acid and bile salt resistance when administered in conjunction with L. acidophilus, a symbiotic organism that may be used in many ways.

Activity of Garlic in Probiotic Growth Stimulation: To be specific, garlic fructan is an insulin-type fructan within the neokestose family due to its (21)-linked -d-Fru f backbone and (26)-linked -d-Fru f side chains. Based on structural models, it has been shown that the high-molecular-weight fructan in garlic has a DP of around 58. This value is determined by the fructose:glucose ratio and the molecular weight of the fructan. (around 15:1) (Xie *et al.,* 2022; Jie *et al.,* 2022). Fructans are considered "non-digestible" carbohydrates because to the fact that they are indigestible by digestive enzymes due to their (21) bonding. (Roberfroid, 2005; Fernández-Lainez *et al.,* 2022). Some of fructans' systemic effects may be attributable to the production of short chain fatty acids (SCFA) during the quick digestion of some fructans (of the inulin type) in the colon. “By selectively boosting the development of Bifidobacteria (and maybe a few other genera), fructans alter the gut microbiota by raising the number of potentially health-beneficial bacteria and lowering the number of potentially harmful species. (Fernández-Lainez *et al.,* 2022; Hernot *et al.,* 2009; Qiang *et al.,* 2009).”

Kubba *et al.* (2021) showed that the Lactobacillus acidophilus isolate grew well and had a favorable impact against Gram-negative bacteria when cultured in a medium containing garlic extract (which is offered as a substrate boosting probiotic growth and activity). The study also noticed that the filtrate of a Lactobacillus acidophilus isolate cultured on De Man, Rogosa and Sharpe agar (MRS) broth enhanced with 20% garlic extract for 48 hours showed an antibacterial activity that was better than 10% but equivalent to 30% against pathogenic bacteria.

Chen *et al.* (2019) reported that whole garlic supplementation may help to reduce High Fat Diet-induced dyslipidemia and gut microbiota disruption (Figure 1). According to their findings, whole garlic may be a possible prebiotic that can protect the gut flora from High Fat Diet-induced disruption.

Turmeric as a prebiotics: Anti-inflammatory, antioxidant, and neurotrophic effects are just some of the reasons why clinical interest in Curcuma longa (turmeric) and its physiologically active ingredient, curcumin, is on the rise across the world. (Rahmani *et al.,* 2019).

Ghiamati *et al.* (2019) discovered that Turmeric Extract (TE) may resist digestion by gastrointestinal (GI) enzymes, and that this, together with its high phenolic and carbohydrate content, suggests it may be useful as a prebiotic in food. It is possible that more research is needed to characterize polysaccharides in TE, evaluate their prebiotic qualities, and use whole TE or TE derivatives in practical culinary applications. Researchers speculated that the existence of pentosans in TE explained the high concentrations of mannose, rhamnose, arabinose, and xylose they discovered. Polymers such as pentosans, and in particular arabinose, have been proven to boost the immune system in laboratory experiments.

Curcumin and turmeric may improve intestinal barrier integrity and provide health advantages despite low absorption; however, further study is required to confirm this. (Ghosh *et al.,* 2018; Lestari *et al.,* 2014). Beneficial health effects may arise from curcumin's potential to keep concentrations high in the intestinal mucosa, alter gut barrier function, and hence decrease levels of circulating bacterial lipopolysaccharide and inflammation. The tight junction proteins and intestinal barrier function are both improved by curcumin supplementation in high-fat-diet-induced rats. In addition, two kinds of Tregs in the gut may better distinguish when treated with curcumin-treated dendritic cells. (Cong *et al.,* 2009). Intestinal epithelial cells (Caco-2) treated with curcumin suppressed pro-inflammatory cytokine production and prevented lipopolysaccharide-induced tight junction protein disruption. (Ghosh, 2017). Changes in the composition and diversity of the gut microbiota will arise from these barrier effects. The estimated worth of turmeric is several million dollars.

CONCLUSION

In conclusion, it was found that Onion, Garlic and Turmeric have potential health benefits as prebiotics based on a wide range of research study. The antimicrobial, cell-supporting, anticarcinogenic, antimutagenic, anti-asthma, anti-immunomodulatory, and prebiotic properties of onion removes, as well as their anti-hypertensive, anti-diabetic, anti-thrombotic, and anti-homocysteinemia effects, have shown their efficacy in the treatment of cardiovascular disease. Lactobacillus acidophilus detach may grow well and have a fair effect against Gram-negative microorganisms in a medium containing garlic remove (which is given as a substrate supporting probiotic development and activity). High phenolic and carbohydrate content of Turmeric Extracts, as well as its resistance to GI enzymes, have led some researchers to believe that it could be used as a prebiotic in real food.

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