

Nutrients and Immunity: A Relative Assessment

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ABSTRACT

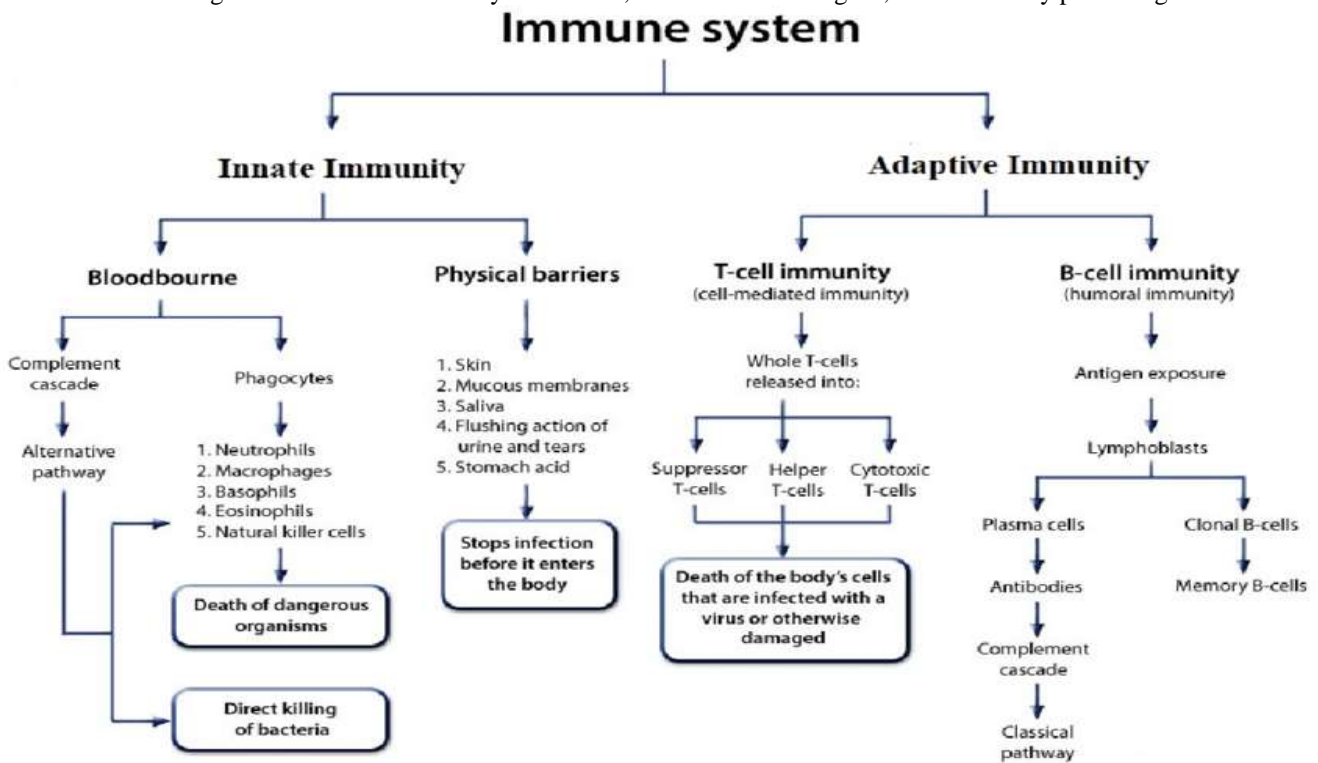
In the present scenario where human life is under continuous threat, dealing with one or the other infections. These infections may be caused by virus, bacteria or any other microorganism. The pandemic COVID-19, has led human race to concentrate seriously on preparing our body to fight against such infections by boosting the immune system. A healthy immune system is the most powerful weapon against such infections.

There are several natural immunity boosters which include foods, fruits, vegetables, herbs, Spices etc. which are tested to provide strength to the immune system. Whereas artificially designed supplements are also known, which boost the immune and helps increase the ability to fight against illnesses. Other than this several herbal products, micronutrients, nutraceutical and probiotics are also considered crucial for enhancing immune response and in promoting health and nutritional well-being. The objective of the present review is to relatively assess & investigate the bioactive components present in consumables and their effect on immune system. The assessment is expected to help in developing a basic understanding regarding the immunomodulatory activities and impact on immune system.

Keywords: Immunity boosters, immunomodulatory, micronutrients, bioactive component etc.

Introduction

What is Immunity? Actually it is nothing but body’s ability to provide resistance or protection against disease and infections caused by pathogens such as viruses, bacteria, parasites, and other harmful microorganisms. All the parts of our body that help us fight against diseases and help improve our immunity are collectively named as the immune system. Immune system has the ability to detect harmful microorganism that enters the body-these cells, also known as antigens, attack them by producing antibodies.



https://www.researchgate.net/figure/Flowchart-of-basic-components-of-human-Immune-system_fig1_342663166

Fig. 1: Flowchart of basic components of human Immune system

There are certain factors which affects the immune function few of which are

1. Effect of stress

It has been observed that a wide variety of maladies, including stomach upset, hives, and even heart disease, are linked to the effects of emotional stress. Modern medicine has come to appreciate the closely linked relationship of mind and body. Most scientists studying the relationship of stress and immune function, however, do not study a sudden, short-lived stressor; rather, than chronic stress, such as that caused by relationships with family, friends, and co-workers, or sustained challenges to perform well at one's work. Some scientists are investigating whether ongoing stress takes a toll on the immune system.

2. Effect of aging

With growing age the number of immune cells also lessens, the communication among these cells gets hampered and therefore they take longer to react to harmful bacteria and cannot defend the body efficiently. There is a clear verdict on the relation of immunity and age therefore elderly people are more liable to catch disease as our immune response capability gets reduced.

The role of T-cells in the immune system is of 'retaining in memory' the harmful antigens to be able to fight against them better in the future. With growing age, the production of T-cells decreases and in turn defense mechanism of body is adversely affected (1).

Few healthy practices for maintaining immunity

Consuming immunity boosters in regular diet, and daily supplements are just a part of developing a healthy immune system. Some daily practices which are required to further maintain healthy living are as follows

- Exercising regularly, maintaining proper hygiene
- Getting vaccinated and immunized to prevent diseases such as pneumonia, flu, hepatitis, and others, taking adequate sleep and keep body hydrated.
- Hygiene and Immune system: Personal hygiene is the best way to protect the body: Proper and frequent washing of hands before any type of work can remove potential contagions and prevent transmission of communicable diseases. Sneezing or coughing with a tissue covering the nose and mouth or coughing on the elbow rather than on hand contributes to good hygiene. Therefore, the easiest way fight against spreading contagious diseases is to maintain a good hygiene. A hand sanitizer can be use if frequent washing is not possible (2-3). Smoking and excessive drinking weaken the immune system so control over these activities is also required.

By sticking to a healthy and nourishing diet, exercising regularly, and consuming daily supplements, one can have an excellent immune system and stay healthy, safe, and active. In this short review, various immunity boosters, having immense potential to prepare our body to fight against diseases are discussed.

Nutrients and Immunity

There are several vitamins and trace elements which are essential for the normal functioning of the immune system. The top ten micronutrients (4), included in new immune-boosting products in the five-year period were: Vitamin C (38 percent), Vitamin D (31 percent), Vitamin B6 (27 percent), Vitamin A (26 percent), Zinc (25 percent), Vitamin E (24 percent), Calcium (24 percent), Folic acid (23 percent), Niacin (23 percent), Vitamin B1 (22 percent).

In addition to micronutrients, several herbs and probiotics (5) also have shown effectiveness for treatment and prevention of viral infections. As known protein-energy malnutrition or even subclinical deficiencies of one micronutrient may impair one's immune responses. The importance of optimal nutritional status to protect against a viral infection and nutritional advices to reduce damages to the lungs from corona virus and other lung infections are also being studied in details. The role of certain essential nutrients (vitamins B6, B9, B12, A, D, C, and Cu, Fe, Zn, Se) are known to contributes significantly to the proper functioning of the immune system and have also shown favorable immune-modulatory effects in viral respiratory infections (6). Still much more work, investigations and trials are required for further studies.

The clinical potential of vitamin A and D metabolites for modulating tissue-specific immune responses and for preventing and/or treating inflammation and autoimmunity is also known. Vitamin D₃ (VD₃), the most physiologically relevant form of vitamin D, is synthesized in the skin from 7-dehydrocholesterol (7). Vitamins modulate a broad range of immune processes, such as lymphocyte activation and proliferation, T-helper-cell differentiation, tissue-specific lymphocyte homing, the production of specific antibody isotypes and regulation of the immune response (8).

There is some evidence that various micronutrient deficiencies — for example, deficiencies of zinc, selenium, iron, copper, folic acid, and vitamins A, B6, C, and E — alter immune responses in human being however, the matter is still under study. Several studies (9-11) have shown the importance of vitamin C, Mg & Zn respectively in building immune system defense however much more investigation and trials are still required.

IMMUNITY BOOSTERS: Some of the immunity booster consumables are mentioned below

1. FRUITS (12-13)

- A. CITRUS FRUITS:** They are rich source of Vitamin C, expected to increase the production of white blood cells, key to fight infections. As human body doesn't produce or store it, one needs daily consumption of vitamin C for continued health. The recommended daily amount for most adults is 75mg for women and 90 mg for men.

Popular citrus fruits include:

- a. Grapefruit
 - b. Oranges
 - c. Clementines (Clementines are small oranges that are seedless, easy to peel, and—when well grown and ripe—perfectly sweet to eat)
 - d. Tangerines (The tangerine (*Citrus reticula* L. var., sometimes referred as *Citrus tangerina*) is a group of orange-colored citrus fruit consisting of hybrids of mandarin orange (*Citrus reticulata*).
 - e. Lemons
 - f. Lime
- B. PAPAYA:** Papayas are rich source of vitamin C and also have a digestive enzyme called papain that has anti-inflammatory effects. Papayas have decent amounts of potassium, magnesium, and folate, all of which are beneficial to your overall health.
- C. KIWI:** Kiwi fruits are naturally full of essential nutrients, including folate, potassium, vitamin K, and vitamin C. They also have a lot of antioxidants and are also rich in fiber. Their small black seeds are edible, as is the fuzzy brown peel, though many prefer to peel it before use.

2. VEGETABLES

A. REDBELL PEPPER: Red bell pepper contains almost 3 times as much vitamin C as oranges may have and also are rich source of beta carotene. Besides boosting immune system, Vitamin C helps maintaining healthy skin. Beta carotene, which body converts into vitamin A, helps keep eyes and skin healthy.

B. BROCCOLI: Broccoli is one of the healthiest vegetables and is a rich source of vitamins (A, C & E), minerals as well as fiber and many antioxidants.

C. GARLIC: Whole garlic contains a compound called alliin. When garlic is crushed or chewed, this compound turns into allicin, which is the main active ingredient in garlic. Allicin contains sulfur, which gives garlic its distinctive smell and taste. However, allicin is unstable, so it quickly converts to other sulphur-containing compounds thought to give garlic its medicinal properties. To maximize the health benefits of garlic, it should be used in following way:

- Crushing or slicing garlic increases the allicin content.
- Let the crushed garlic stand for 10 minutes, before cooking.
- Consuming more than one garlic clove per meal, is beneficial for health.

The minimum effective dose for raw garlic is one segment (clove) consumed two to three times per day.

D. GINGER: It is packed with active constituents such as phenolic and terpene compounds. Ginger may help decrease inflammation, which can help reduce a sore throat and inflammatory illnesses and nausea as well. While it is used in many sweet desserts, ginger packs some heat in the form of gingerol, a relative of capsaicin. Ginger may also decrease chronic pain and might even possess cholesterol lowering properties.

E. SPINACH: It is rich in vitamin C, beta carotene and has several antioxidants, they increase the infection-fighting ability of immune systems. However, light cooking makes it easier to absorb the vitamin A and allows other nutrients to be released from oxalic acid, an antinutrient.

Consumables rich in Vitamin D, E, B6, Zn & Selenium

All kinds of berries, along with foods rich in omega-3 fatty acids such as beans, flax seeds, and even some nuts can be consumed to strengthen immunity.

A. POULTRY: Chicken and turkey, are high in vitamin B-6. Vitamin B-6 is an important player in many of the chemical reactions occurring in the body. It is also vital for the formation of new and healthy red blood cells. About 3 ounces of 1 chicken meat contains nearly one-third of your daily recommended amount of B-6. Stock or broth made by boiling chicken bones contains gelatin, chondroitin, and other nutrients helpful for gut healing and immunity.

B. SHELL FISH: It contains protein and omega-3 fatty acids. They also contain high amounts of certain micronutrients, including iron, zinc, magnesium, and vitamin B12. Varieties of shellfish that are high in zinc include: oysters, crabs, lobsters, mussels. Daily recommended amount of zinc in diet is: 11 mg for adult men & 8 mg for most adult women.

C. GREEN TEA: Green and black teas are packed with flavonoids, a type of antioxidant. Green tea has high level of epigallocatechin gallate (EGCG), a powerful antioxidant. EGCG has shown to enhance immune function. The fermentation process black tea goes through destroys a lot of the EGCG. Green tea, on the other hand, is steamed and not fermented, so the EGCG is preserved.

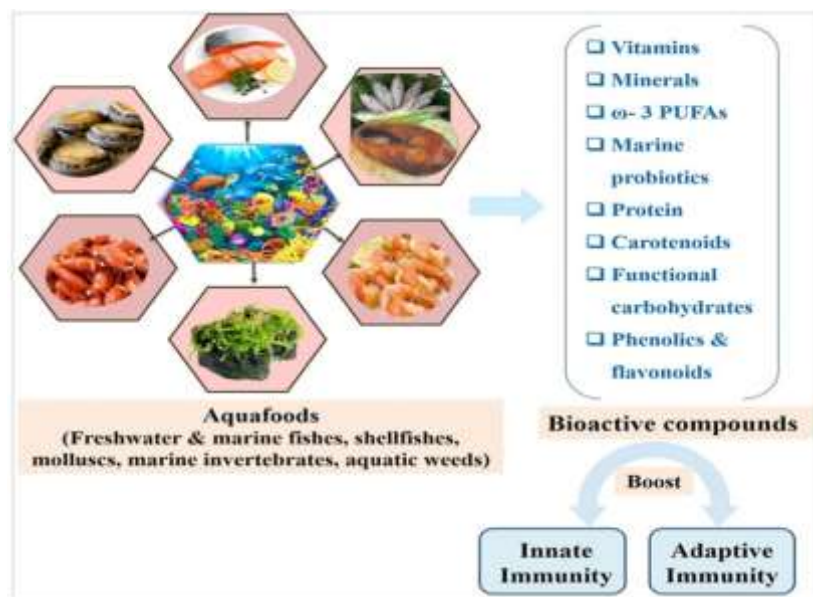
Apart from antioxidant, green tea is also a good source of the amino acid L-theanine. L-theanine may aid in the production of germ-fighting compounds in your T cells.

D. YOGHURT: Yogurt is also a great source of vitamin D. It helps regulate the immune system and is thought to boost our body's natural defenses against diseases.

E. SUNFLOWER SEEDS: Sunflower seeds are full of nutrients, including phosphorous, magnesium, selenium and vitamins B-6 and E. Vitamin E is important in regulating and maintaining immune system function. Other foods with high amounts of vitamin E include avocados and dark leafy greens.

F. ALMONDS: Nuts, such as almonds, are packed with the vitamin and also have healthy fats. Almonds are powerful antioxidant and key to a healthy immune system. It's a fat-soluble vitamin, which means it requires the presence of fat to be absorbed properly. Adults need about 15 mg of vitamin E daily. A half-cup serving of almonds, which is about 46 whole, shelled almonds, provides around 100 percent of the recommended daily amount.

AQUA FOODS



<https://doi.org/10.1016/j.heliyon.2022.e09547>

Figure 2: Aqua food rich in nutrients

As mentioned in the above figure sea food contains various bio-potential compounds such as vitamins, minerals, proteins, polysaccharides, polyunsaturated fatty acids (PUFAs), carotenoids, probiotics, etc. are available in aquatic organisms which boost our immunity. Several observational and clinical trials showed that bioactives from aquafoods, e. g., fishes, crustaceans, molluscs, seaweeds, etc. are involved with immune modulation, reduce the risk of influenza, and recover respiratory syndrome. So, aquafoods and their valuable compounds are highly recommended for the patients with the above mentioned problems (14).

Supplements for Boosting Immunity

Whenever essential vitamins and minerals are lacking in our natural diet or regular diet is failing to provide all the vital immunity boosters. That's where dietary supplements come in to picture. Supplements like Vitamins B6, B complex, C, D and E, Zinc, selenium have been shown to help boost your immune system," Hansen says. "If you are lacking some of these vitamins, a supplement could help support your immune system. But, your body can only absorb so much of any vitamin in a given day. So, if you are taking too many of these vitamins, you're going to get rid of the extra in your urine. However supplements can cause side effects as well.

FEW IMMUNITY BOOSTING HERBS/SPICES

Some of the immunity-boosting herbs includes turmeric, garlic, black cumin, licorice (*Glycyrrhiza glabra*), moench, astragalus, angelica and chamomile (15) Licorice is a plant used for flavoring food, beverages, and tobacco. The root issued as a natural, herbal supplement for medicinal purposes. Chemicals in licorice may reduce inflammation, thin mucus secretions, decrease cough, and increase the body's ability to heal ulcers. The major component of licorice is saponin known as glycyrrhizin, also known as glycyrrhizic acid, which is extremely sweet, foaming triterpene glycoside. Glycyrrhiza consists mainly of 20% starch, up to 6.5% glucose, 2-4% asparagines, 8% fat, resins, mannitol, gumprotein, a trace of tannin, .03% volatile oils, bitter principles and other constituents. It initiates the production of hormones such as hydrocortisone.

- A. TURMERIC:** High concentrations of curcumin, gives turmeric its distinctive color, can help decrease exercise-induced muscle damage. Antimicrobial activity of curcumin made it a good candidate to enhance the inhibitory effect of existing antimicrobial agents through synergism. Curcumin has a broad spectrum of biological actions, including antibacterial, antiviral, antifungal, antioxidant and anti-inflammatory activities (16). It inhibits the production of proinflammatory cytokines (IL-6 and TNF- α) in lipopolysaccharide (LPS). Curcumin exerts antiviral effect on a broad range of viruses including influenza virus, hepatitis, human papilloma virus (HPV), human immunodeficiency virus (HIV), herpes simplex virus-2 (HSV-2) and Zika viruses (17).
- B. CHAMOMILE:** It has been investigated to exhibit the antioxidative and antimicrobial activity. The obtained results proved the presence of 52 components, wherein the highest content of β -farnesene (29.8 %), α -farnesene (9.3 %), α -bisabolol and its oxide (15.7 %), chamazulene (6.4 %), germacrene D (6.2 %) and spiroether (5.6 %) is determined. Chamomile essential oil has shown the best antioxidant properties after 90 minutes of incubation with EC₅₀ value of 2.07 mg/ml.
- C. ECHINACEA PURPUREA (L.) Moench** is one of the most important and well-known medicinal plants in the world, belonging to the Asteraceae (Compositae) family. It has been mainly used in chemo-preventive and chemotherapy for infectious diseases in both upper and lower respiratory systems. Alkamides, caffeic acid derivatives, and polysaccharides have been considered important constituents of the plant. A number of studies revealed that alkamides are involved in the immunomodulatory properties. The polysaccharides play an important role in the anti-inflammatory effect of *Echinacea* preparations.
- D. ASTRAGALUS:** It is an herb and its root is used to make medicine. Used in treatment of hay fever, diabetes, kidney disease, and many other conditions, but there is no good scientific evidence to support these uses. Some species of astragalus contains a nerve toxin and have been linked to livestock poisonings. Most astragalus supplements contain *Astragalus membranaceus*. Although astragalus may have some antiviral activity, there is no strong evidence to support it. Astragalus seems to stimulate and increase the immune system.
- E. ANGELICA:** It is a plant whose root, seed, leaf, and fruit are used to make medicine. The dominant component of it is α -pinene (15.7–20.8%). Other constituents include δ -3-carene (15.4–16.9%), limonene (8.0–9.2%), sabinene (5.0–7.5%) and δ -phellandrene (13.5–15.4%), δ -3-carene (13.2–14.2%) and α -phellandrene (8.0–9.1%). A part from other uses it is widely used to modulate the immune system (18).

IMMUNITY BOOSTING DRINKS

A. HONEY IN DRINKS



Honey contains a number of enzymes, including invertase, which converts sucrose to glucose and fructose; amylase, which breaks starch down into smaller units; glucose oxidase, which converts glucose to gluconolactone, which in turn yields gluconic acid and hydrogen peroxide; catalase, which breaks down the peroxide formed by glucose oxidase to water and oxygen; and acid phosphorylase, which removes inorganic phosphate from organic phosphates. Honey also contains eighteen free amino acids, of which the most abundant is proline. Vitamins, minerals and antioxidants Honey contains trace amounts of the B vitamins riboflavin, niacin, folic acid, pantothenic acid and vitamin B6. It also contains ascorbic acid (vitamin C), and the minerals calcium, iron, zinc, potassium, phosphorous, magnesium, selenium, chromium and manganese.

The main group of antioxidants in honey includes flavonoids, of which one, pinocembrin, is unique to honey and bee propolis. Ascorbic acid, catalase and selenium are also antioxidants. It is general observation that the darker the honey, the greater its antioxidising properties. Honey also contains organic acids such as acetic, butanoic, formic, citric, succinic, lactic, malic, pyroglutamic and gluconic acids, and a number of aromatic acids. The main acid present is gluconic acid, formed in the breakdown of glucose by glucose oxidase. Honey also contains hydroxymethylfurfural (19), a natural product of the breakdown of simple sugars below pH 5.

B. KADHA (DECOCTION)

Kadha is an ayurvedic drink (20) which includes herbs and spices, boiled in water for a length of time allowing the extraction of its content, having the medicinal benefits. Cardamom and black pepper are helpful in flu and different allergic problems. Cinnamon and ginger also aid digestion, which has direct impact on our immunity, as our first line of defense is in the gut.



Contents of Kadha

- a. Cardamom: It contains steam volatile oil, fixed (fatty) oil, pigments, proteins, cellulose, pentosans, sugars, starch, silica, calcium oxalate and minerals.
- b. Cinnamon: Cinnamon consists of a variety of resinous compounds, including cinnamaldehyde, cinnamate, cinnamic acid, and numerous essential oils.
- c. Dried Ginger: Chemical analysis of ginger (*Zingiber officinale*) shows that it contains over 400 different compounds. The major constituents in ginger rhizomes are carbohydrates (50–70%), lipids (3–8%), terpenes, and phenolic compounds. Terpene components of ginger include zingiberene, β -bisabolene, α -farnesene, β -sesquiphellandrene, and α -curcumene, while phenolic compounds include gingerol, paradols, and shogaol. These gingerols (23–25%) and shogaol (18–25%) are found in higher quantity than others. Besides these, amino acids, raw fiber, ash, protein, phytosterols, vitamins (e.g., nicotinic acid and vitamin A), and minerals are also present.
- d. Black pepper: Contains piperine as the main bioactive compound (naturally occurring alkaloid) it also contains volatile essential oils.
- e. Honey is optional and is added for taste.

B. FRUIT/VEGETABLE JUICES:



Fruits/vegetables like tomato, carrot, berries, kiwi, watermelon, oranges, apple, spinach etc are rich in nutrients and are therefore advised to be taken for improved immunity

- D. **PROBIOTICS:** Human body is infested with different kinds of bacteria of which some bacteria are actually very good. The good bugs lives in stomach and help to properly digest the food, as well as aid in other essential bodily functions.



Lactobacillus probiotics are things like yogurt and other fermented foods which, when eaten, aid in the digestive process. Few researches indicate that probiotics may help aid: skin conditions, urinary and vaginal health, oral disease, as well as allergy management. A study showed, 28 bacterial strains isolated from spontaneous fermentation of soymilk were assessed for probiotic characteristics such as low pH resistance, bile salts resistance, antibacterial activity and hemolysis test. From the 28 organisms, 9 were selected as probiotics because they showed resistance to pH 2.5, bile salt (0.4%) and none of them had hemolytic activity. They also showed resistance to a spectrum of antibiotics and were able to inhibit the growth of pathogenic Gram positive and Gram negative indicator organisms. Few of the bacteria; strains were able to degrade both raffinose and stachyose which are regarded as non-digestible oligosaccharides by humans. Probiotics are available in both pills as well as in food items (21).

- E. NUTRACEUTICALS:** Nutraceuticals are high-absorbing nutritional supplements. They are pharmaceutical grade vitamins that are derived from food, and designed for the management of certain health conditions.



Image courtesy cureill pharma

People will commonly confuse nutraceuticals with their distant cousins: vitamins or nutritional supplements. These are super-powered vitamins used to manage oral diseases and aid in the mouths recovery. They are formulated to give the body the essential nutrients to build jaw bone, protect tooth enamel, and maintain the health of your gums. They are such foodstuff (as a fortified food or dietary supplement) that has been shown to provide health benefits in addition to its basic nutritional value.

A research group has demonstrated that immune and epithelial cells can discriminate between different microbial and bioactive plant species has extended the known mechanism(s) of action of nutraceuticals and probiotics beyond simple nutrition and/or antimicrobial effects. The progressive unravelling of their effects on systemic immune and intestinal epithelial cell function has led to new credence for the use of probiotics and nutraceuticals in clinical medicine. The use of nutraceuticals and probiotics as therapeutic agents for gastrointestinal disorders is rapidly moving into clinical usage. Thus these products can support or mediate aspects of immunity via interaction with the digestive tract (22).

CONCLUSION

The relative assessment of nutritional intake and immune clearly highlights that the bioactive components present in various food items (healthy diet) as well as active lifestyle, physical exercise, relaxation and sound sleep are certainly the ways to boost immunity. Immune system plays a fundamental role in fighting against infections, acquiring immunity after vaccination, establishing the first line of defense after infection, and also for fighting against disease. Therefore our efforts should be directed towards improving the nutritional intake. Certain essential nutrients like vitamins B6, B9, B12, A, D, C, and Cu, Fe, Zn, Se are known to contribute significantly to the proper functioning of the immune system and have shown favorable immune-modulatory effects in viral respiratory infections. Vitamins D, C, Zn, and Se have been thoroughly studied to show favorable immune response in viral

respiratory infections and also improve the immune system to fight against COVID-19 disease. Similarly, it is also established that nutraceutical and probiotics may also have some role in enhancing immune functions.

The present study relatively assesses the immunomodulatory activities of various naturally occurring fruits, vegetables, immune boosting drinks, supplements, probiotic & nutraceutical, which plays vital role in maintaining good health. All of the above mentioned consumables have been expected to have definite immune modulatory capacities and this is because of the bioactive components possessed by each of them. This review also aims to develop an understanding among people to achieve a recommended amount of nutrition in form of various vitamins (C, D, B₆, and B₁₂), minerals like Zn, Se etc. as well as micronutrients so as to enhance the immunity.

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