Humans’ Body Immunity and Natural Pigments

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Abstract

The emerging pandemic of Corona Virus Disease (COVID-19) has attracted special concerns regarding the case of very contagious viral infection. Besides the profound waiting toward vaccine development, public awareness was also addressed into the effort of increasing humans’ body immunity. Nowadays, the people are encouraged to consume adequate amount of vitamin C and increase the consumption of fruits and vegetables. In addition, various kinds of food supplements are offered and claimed to give us protection and prevention against viral infection by boosting our immune system. However, the communities are actually lack of proper information regarding the true mechanism of immune system. How is the infection developed in our body? How does the immune system work? Could it be modulated by consuming the bioactive compounds? Here, the stages of infection, the immune system, as well as the role of natural pigments to support the humans’ body immunity will be briefly discussed.

INTRODUCTION

Since the early cases were announced by the end of 2019, the spread of corona virus disease (COVID-19) has been unstoppable into almost all region of the world. The restriction issues for travel and people activities are also difficult to be applied in prolonged period, mainly due to economic reasons. To date, although some medicines could be recommended to ease the disease and the development of vacciness is also under intensive efforts, the communities are urged to keep the healthy life in order to make sure that the immune system works in optimal condition.

The immune system is the defense array that protect the body when any invasive object enters the body, for instance through nasal and or oral conduit. The invasive objects could be in the form of microorganisms, such as pathogenic viruses, bacteria, and protozoa, which are invisible before our naked eyes. In fact, the microorganisms always exist in our environment, including in our daily food, and it is impossible to absolutely eliminate them all. They may come in unwittingly and will cause disease when the amount exceeds the threshold.

Humans’ body are bestowed with the immune system in order to balance the interaction between the invasive objects and the host. However, why some stay healthy while the others getting sick? In the case of same diagnosed disease, why some could be recovered soon while the others getting worse? How can we improve our immune system?

On the other hands, it has been well-understood that the dietary impacts on the immune system as well as health status [1]. The basic recommended diet to keep the function of growth, maintenance, and repair for good health consists of adequate amounts of carbohydrates, proteins, fats, vitamins, and minerals. Nevertheless, numerous studies have revealed that several non-nutritive bioactive compounds also bring impacts on human health, such as carotenoids, flavonoids, phenolic acids, alkaloids, coumarins, saponins and terpenoids. They were observed to provide varied biological effects, such...
Our immunity system is generally composed of two major parts, i.e. innate immunity and adaptive immunity [4]. Innate immunity is the first defence which is ready to protect our body anytime. While adaptive immunity works when the innate immunity is overwhelmed. Furthermore, the adaptive immunity could be stored in the human body’s memory thus could be activated when the same infection occurred. This principle is used as a basis for developing vaccines.

Figure 1 gives illustration to distinguish the innate and adaptive immunity. When the bacteria or viruses infects our body, there will be a competition between the rate of their multiplication with our immune response to block them. Within the first 0-12 hours, the innate immunity will attack the microbes and produce cytokine protein. When the innate immunity is starting overwhelmed due to the prompt amount of viruses, the intense production of cytokine proteins provides the signal to rouse the adaptive immunity. The activation of adaptive immunity takes at least 5 to 7 days to response the infection. This stage can be identified as an inflammation response. The people often begin to realize this stage through the symptoms of sorethroat, cough, runny nose, hoarseness, and red or runny eyes.

It the other words, when the first response (innate immunity) successfully overcomes the infection, the number of active viruses inside the body is suppressed, thus we are not getting sick. Even though at this condition the people may not show any symptoms, they are still able to transmit the active viruses to other people. However, when the second response (adaptive immunity) has already initiated, meaning that there has been the obvious symptoms, the number of active viruses become greater and getting very contagious.

One of the major problems in controlling the spread of coronavirus is the difficulties to detect and keep watch the group of infected people who have no symptoms. This group may consist of the young communities whose immune system is working at good performance, being able to suppress the multiplication of viruses at the early stages of infection.

Furthermore, the occurrence of inflammation could be learned according to the oxidative imbalance in the cells. The metabolism of cells in aerobic organisms always require oxygen and hence the production of reactive oxygen species (ROS) can not be hindered. In fact, the ROS is pro-oxidant and may danger the cell, but the aerobic organisms are designed to have antioxidant enzymes to neutralize them, such as the SOD, catalase, and so on. Those enzymes are naturally produced in our body. In the homeostasis (normal) condition, the presence of these antioxidants is adequate to scavenge the produced ROS during metabolism process.

Nevertheless, the presence infection will disturb the homeostasis. When the virus binds with the cell membrane, the virus will try to penetrate and utilize the cells’ materials to perform its replication. The immune system will work and cause elevation in the production of both cytokine proteins and ROS. When the body is not able to provide sufficient antioxidants, or there are many exogenous radicals due to inappropriate lifestyle, the excessive ROS inside the cell will cause oxidative stress and lead to the preparation of cell death. At the same time, uncontrolled cytokines release causes the cytokine storm.

The progression of cytokine storm and epithelial barrier disruption due to viral infection in respiratory tract are depicted in Figure 2. Many scientists believed that the prevalence of viral infection has a very close relation with bacterial infection. The enhanced production of ROS may cause barrier dysfunction
of the epithelial cells, thus increase the susceptibility of host toward pathogenic bacteria [5]. In the case of COVID-19, there is also a supposition that the aggresion of corona virus might work synergistically by the contribution of bacterial pathogens.

Further damage of epithelial cells weaken the boundary surface of respiratory tissues. Since the respiratory system also comprises vital role of oxygen/carbondioxide exchanges between the air and the blood, respiratory infection might spread into the other organs in the body. Consequently, when the immunity system could not restrain these infections, there will be septic shock and multiple organs failure.

The development of cytokine storm likewise increases the susceptibility of the body against further infection. The cytokines is normally produced and functioned for a while when the immune system works in the area of infection. However, the uncontrollable cytokines signalling causes the immune array to work continually and out of control. Severe inflammation will surely reduce the power of immunity system. Comparatively, the people who have degenerative diseases, such as diabetic, hypertension, etc., are greatly susceptible to COVID-19 and often bear the risk of higher fatality rate.

THE MODULATION OF IMMUNE SYSTEM

Today's several terms related to human bodys' immune system are getting more familiar, for example the claims of several commercial produces as immunomodulator, immunostimulant, immune booster, etc. Immunomodulator is any compound or drug that either suppress or stimulate the immune system. The first is called as immunosupressant, whereas the later is named as immunostimulant. Furthermore, although the term of immune booster has been the most popular one, the only evidence-based product of this is the vaccines [6]. The basic principle of vaccination is to "boost" the adaptive immunity. The body is exposed to the antigen without causing disease, thus when the living pathogen infects the body, the response could be fast and related disease should be averted.

Then, is it possible to increase the immune system? The closest approach that would be agreed is probably the 'immune support'. Considering the main principle of basic building blocks of biomolecules in the body, nutritional support should be provided sufficiently in order to maintain a proper immune status. In the other words, healthy diet rich in fruit and vegetables should be first familiarized rather than expectance toward food supplements with certain claims for boosting immunity. At the same time, the role of non-nutritive bioactive components in the fruits and vegetables should be well-understood.

One of the basic and most common term of bioactivity is antioxidant. The antioxidative compound has the ability either to prevent the formation of radicals or to quench the radicals. The antioxidant is often a hydroxgen donor that is able to complete the unpaired electron of the radicals without being radical itself. This function is getting important to prevent the chain reaction of radicals propagation, particularly when it occurs in the vital components of the cell, such as the genetic materials, protein synthesis, as well as the cell membrane. The radical quenching is supposed to delay the oxidative imbalance in the cells, accordingly restrain the damage on epithelial cells and maintain the rigidity against any bacterial infection.

NATURAL PIGMENTS AS ANTIOXIDANTS

Some vitamins have been reported possessing the antioxidant activity, such as vitamin C, D, and E. Although they could be obtained through our daily diet, those vitamins are mostly now available in the form of supplements and highly in demand during pandemic season. In addition, the sunbathing activity is often recommended to aid the vitamin D production in the skin tissues.

Besides the vitamins, many natural compounds are also known to posses antioxidative properties, including plant pigments such as carotenoids, anthocyanines, and betalains. Interestingly, natural pigments from plants actually have much higher antioxidant activity than vitamins. Some eminent carotenoids showed supreme quenching rate against singlet oxygen, i.e. astaxanthin, canthaxanthin, α-carotene, β-carotene, β-cryptoxanthin, fucoxanthin, lycopene, lutein, and zeaxanthin [7]. The antioxidant capacity of astaxanthin pigment equals to 500 times higher than vitamin E or 560 times higher than catechin in green tea or 6,000 times higher than vitamin C. This remarkable activity is not only for astaxanthin but also for lycopene, lutein, and β-carotene which are easily found in our daily food such as tomato, egg yolk, corn, as well as carrot.

The most possible reason of this property is the photoprotective function of carotenoids in the light harvesting antenna of photosynthesis apparatus in plants. Carotenoids belong to the accessory pigments that accompany chlorophylls as the primary photosynthetic pigments. Having the carbon chain backbone with conjugative double bonds, carotenoids structure is able to quench the radicals produced during light harvesting without becoming radicals. Moreover, carotenoids structure is compatible to be embedded in the lipid bilayer of cell membrane in order to stabilize and photoprotect the lipid phase. When plants are exposed to stressed environments, the

Figure 2. The progression of cytokine storm and epithelial barrier disruption following viral infection.
Brotosudarmo

selection of food supplements. Adequate amount is the key to maximize the benefit of food.

Excessive production of carotenoids will be modulated to increase membrane thermostability and lower susceptibility to lipid peroxidation [8, 9].

Figure 3 provides illustration of the location of carotenoids in lipid bilayer membrane. This position is obviously aid the cells to protect the inner part. Lipid is the most susceptible compound against oxidation, and membrane integrity is vital for the cell life and activities.

Yellow, orange, and red fruits could be the best carotenoids source, i.e. carotenes (from carrots, oranges, mangoes, and persimmons) and lycopene (from tomatoes, red guava, and watermelons). Other carotenoids could be also found in several animals, algae, and flowers such as astaxanthin (salmon, shrimp, krill, red algae), lutein (marigold) and crocin (saffron). Recent research reported that lycopene consumption help to maintain the lung’s healthy and shortness of breath healing. Furthermore, saffron is widely used as an influenza antiviral agent in subtropical countries.

Furthermore, other groups of natural pigments also evidently support immune system to combat the viral infection through non-antioxidative mechanisms. Berry fruits are found to have a significant amount of anthocyanines, giving the color of purple, blue, or red. This group of fruit is also well-known for their anti-influenza activity. Common berry fruits in Indonesia are strawberry, blueberry, raspberry, and blackberry. The antiviral activity of this group is generated by inhibiting the virus reproduction process through binding with the neuraminidase active site on the surface of the virus capsule.

Another group of red pigment is the betalains. Beet root and red dragon fruits are famous tropical fruits with a significant content of betalain pigments. It was reported that betalain gave anti-inflammation activity through an inhibition mechanism of pro-inflammatory cytokines then triggering the production of anti-inflammatory cytokines.

According to the simplest rule of healthy diet, neither excessive nor scant consumption is recommended, but an adequate amount is the key to maximize the benefit of food content. It is important to consume various colorful vegetables and fruits. The same rule might also be adopted upon the selection of food supplements. However, it should be noted that the consumption of food supplements can not replace the main food itself, meaning that applying healthy diet is a must.

Adequate consumption of fruits and vegetables is strongly recommended to maintain the immunity system instead of food supplements [10]. Vegetables and fruits also contain other beneficial compounds, such as dietary fibers, minerals, as well as other phytonutrients which are good for proper metabolism and healthy life. However, it is undeniable that the communities of modern lifestyle consume more highly-processed food rather than fresh produce. Thus, the antioxidant and food supplements are often required.

CONCLUSION

Overall, the humans’ body immunity consists of innate and adaptive system that will work according to the stages of infections. The immunity system can be maintained or supported through the responsible practice of healthy life and balanced diet. Natural pigments have contribution to support the immune system through its excellent antioxidant, antiviral, and antiinflammatory properties. Various colorful commodities are recommended to obtain the health benefits of natural pigments.

REFERENCES


Abstrak

Kata kunci: imunitas, pigmen alami, antioksidan, stres oksidatif