pH, Presents a New Weapon in the Battle Against COVID-19

Introduction

As of March 2020, according to the report from recent news, an estimated more than 1.7 billion people around the world had been ordered to “Stay-at-Home” or affected by country lockdown because of COVID-19 [1]. People are living in the lockdown scenario continuously exposed to the unknown condition of the virus. We need to supply Personal Protective Equipment (PPE) and disinfectant materials such as detergents, alcohol and surfactants to individuals as quickly as possible. However, with the current rapid spreading rate of COVID-19 globally, PPEs, disinfectants, and related protocols are challenging to arrive in time. Besides the cleanse of the coronavirus on rough surfaces and human skin, sometimes we need to remove the potential coronavirus resided on the delicate surface of items such as fresh-produces and foods. For the 1.7 billion population in lockdown, it is vital to provide fresh and active food without any concern while keeping the waste materials at minimum is essential at this critical time. Lack of essential nutrients, vitamins, and trace elements make the immune system weaken and suspect more human beings against COVID-19 [2].

Information from the structure of COVID-19 pointed out that this specific virus, SARS-CoV-2, contains a lipid envelope, which keeps this coronavirus invincible [3]. The entry mechanism of SARS-CoV-2 in COVID-19 uses S-1 spike proteins to attach to numerous ACE receptors in the human respiratory tract. ACE-2 receptors on the human lungs are the primary docking site for COVID-19’s S-1 spike protein to attach [3]. In recent study on the virus structure of COVID-19, which SARS-CoV-2 belongs to the beta coronavirus subtype [4]. The virus has a round outer lipid bilayer membrane that has a diameter of approximately 60-140 nm [4]. Like other coronaviruses, SARS-CoV-2’s lipid bilayer membrane is sensitive to UV and heat treatments. Furthermore, the SARS-CoV-2 virus in COVID-19 can be inactivated effectively by lipid solvents such as ether (75%) solution, ethanol, chlorine disinfectant, peroxyacetic acid (pH=2.0), citric acid/vinegar (pH=2.0), and Coke and Pepsi (pH=2.5) [3]. These acidic fluids are cheap, affordable, easier to obtain by normal civilians. According to a study on HIV prevention and treatment by [9]. These acidic fluids are cheap, affordable, easier to obtain by normal civilians. According to a study on HIV prevention and treatment by [9]. They found out that the optimal stability of the virus was at pH 6, at both 4 °C and 33 °C. However, when the virus is at extreme pH levels, it was more stable when incubated at 4 °C. When they exposed the virus in pH 4 or pH 9 at 33 °C, viral infectivity was not detectable. Another investigation discovered that this coronavirus was inactivated by the use Ultraviolet Light (UV), use of heat treatment 65 °C or higher, place the virus in alkaline (pH>12) or acidic (pH<3) conditions, also treat the virus with formalin and glutaraldehyde [6]. A study indicated that the survival rate of coronavirus SARS COV-1 to host cells was affected by low pH levels and warm temperatures [7,8]. The activity of coronavirus decreases when the pH is lower than neutral (pH<7.0) and when the temperature increase from 20 °C to 37 °C [7]. This study can be useful when dealing with COVID-19 since the stability and functionalities are similar to SARS-CoV-1 (Figure 1).

In our daily life, a wide range of acidic fluids with different pH levels ranging from pH 2.0 – pH 5.0 was available to buy and use. Orange or grapefruit juice (pH=3.0), acetic acid/lemon juice (pH=2.0), citric acid/vinegar (pH=2.0), and Coke and Pepsi (pH=2.5) [9]. These acidic fluids are cheap, affordable, easier to obtain by normal civilians. According to a study on HIV prevention and treatment by using lemon juice and lime juice, Short et al. pointed out that when acidic solution mixed with human serums, the combined pH level...
around 4.0–4.3 can prevent HIV infecting the human host [8]. They also mentioned a study carried out by the team in 2004 on the use of fresh lemon or lime juice (pH=2.3 and 2.4 respectively) at 20% concentration could inactivate viruses [10]. The protocol uses filtered pools of lemon juice (pH 2.3) and lime juice (pH 2.4), which added in a duration time exposure to observe the outcome. Furthermore, we can utilize these acidic fluids to test the activity of spike protein for viral entry.

Conclusions

Since plenty of the acidic liquid listed above are available with minimum or at least known side effect on the food surface. It would be great if the effect of dosage, time, and temperature can monitor the effect on inactive the COVID-19. The potential simple protocol could save many people from immunodeficiency because of malnutrition and save much food to serve as virus-free.

References

1. Davidson H (2020) Around 20% of global population under coronavirus lockdown. Coronavirus outbreak.
2. Maggini S, Pierre A, Calder PC (2018) Immune function and micronutrient requirements change over the life course. Nutrients 10: 15331.
3. Ashour HM, Elkhathib WF, Md Masudur R, Elshabrawy HA (2020) Insights into the recent 2019 novel coronavirus (SARS-CoV-2) in light of past human coronavirus outbreaks. Pathogens 9: 186.
4. Cascella M, Rajnik M, Cuomo A, Dulebohn SC, Di Napoli R (2020) Features, Viral Entry, and Prevention of Coronavirus Infections. Clinical Infectious Diseases 71(8): 1610-1613.
5. Lai MY, Cheng PK, Lim WW (2005) Survival of severe acute respiratory syndrome coronavirus that induces severe acute respiratory syndrome, SARS-CoV. J Virol 79: 1246-1250.
6. Darnell ME, Subbarao K, Feinstone SM, Taylor DR (2004) Inactivation of the Spike Protein and Promote the Release of Infectious Virus. Westerbeck et al. [13]
7. The Infectious Bronchitis Virus (IBV) can increases pH level in the Golgi complex to preserve viral entry; lower than 5.5 can block the process. Room Temperature
8. The Potential of Coconut Oil and its Derivatives as Effective and Safe Antiviral Agents Against the Novel Coronavirus (nCoV-2019) Dayrit F. et al.[12]
9. Since plenty of the acidic liquid listed above are available with minimum or at least known side effect on the food surface. It would be great if the effect of dosage, time, and temperature can monitor the effect on inactive the COVID-19. The potential simple protocol could save many people from immunodeficiency because of malnutrition and save much food to serve as virus-free.

Table 1: Literatures and studies describing the relationship between viral infection and pH level.

| Title | Type of Article | Type of Virus Studied | pH Level Observed | Temperature | Relationship found on viral infection and changes in pH level |
|-------|-----------------|-----------------------|-------------------|-------------|----------------------------------------------------------|
| Effect of pH and temperature on the infectivity of human coronavirus 229E Lamarre A. et al. [5] | Case Study | Human coronavirus 229E (HCV-229E) | 6.0 to 8.0 | Experiment conducted in 4, 22, 33 and 37°C. | pH level between 6.0 to 8.0 is ideal for coronavirus 229E to grow. An acidic pH below 6.0 at 37°C show decrease in viral infectivity. |
| Survival of severe acute respiratory syndrome coronavirus Lai et al. [7] | Case Study | Severe Respiratory Coronavirus Type-1 (SARS-CoV) | >9.0 | Room Temperature | Stool specimens injected with SARS-CoV show higher survival rate at pH level higher than 9 when observed in room temperature. |
| A pH-dependent switch mediates conformational masking of SARS-CoV-2 spike Zhou T. et al. [11] | Case study | Severe Respiratory Coronavirus Type-2 (SARS-CoV-2) | 5.5-6.0 ideal for viral entry; lower than 5.5 can block the process | Room Temperature | pH 5.5 - 6.0 is favored by SARS-CoV-2 spike protein RBD to actively engage with epithelial cell receptors. Therefore, by altering pH level or masking the “UP” RBD conformation can potentially block viral infection. |
| The Potential of Coconut Oil and its Derivatives as Effective and Safe Antiviral Agents Against the Novel Coronavirus (nCoV-2019) Dayrit F. et al.[12] | Review article/Experiment Suggestion | Severe Respiratory Coronavirus Type-2 (SARS-CoV-2) | N/A | Room Temperature | The use of lauric acid from coconut oil can potentially block viral entry by balancing the pH level of an acidic body that normally favors viral infection. |
| The Infectious Bronchitis Virus Envelope Protein Alters Golgi pH To Protect the Spike Protein and Promote the Release of Infectious Virus Westerbeck et al. [13] | Case Study | Coronaviruses (CoVs) | 6.2-6.7; > 6.7 for better survival of virus | Room Temperature | Infectious Bronchitis Virus (IBV) can increases pH level in the Golgi complex to preserve the spike protein for viral infection. Therefore, pH over 6.7 allow better success for viral entry. |
as Effective and Safe Antiviral Agents Against the Novel Coronavirus (nCoV-2019).

13. Westerbeck JW, Machamer CE (2019) The infectious bronchitis coronavirus envelope protein alters Golgi pH To protect the spike protein and promote the release of infectious virus. Journal of Virology.

14. Saghiri, M.A, Saghiri, A.M (2017) In memoriam: Dr. Hajar Afsar Lajevardi MD, MSc, MS (1955–2015). Iran J. Pediatr. 27 (1), e8093.