Avens Publishing Group
J Oral Biol
July 2020 Volume 7 Issue 2

Open Access Opinion Article

Journal of Oral Biology

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

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Submission: 22-May-2020
Accepted: 18-July-2020
Published: 21-July-2020

Keywords

COVID-19; Saliva; SARS-CoV-2; pH

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, and some chloroform [4].

Applying the method to sterilization, such as the use of detergent, surfactant, UV, and heat treatment can deteriorate precious produces, food, and other delicate materials. Instead, we need to find alternative methods to remove SARS-CoV-2 from the delicate surfaces. Listed studies and reviews have pointed out how an alteration in pH level can affect virus activities in human body (Table 1). The extreme acidic or basic environment can potentially inhibit the virus's function on stability and transmission. In the study human coronavirus 229E was diluted 10-fold in buffers at different pH levels and incubated for 6 hours [5]. 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

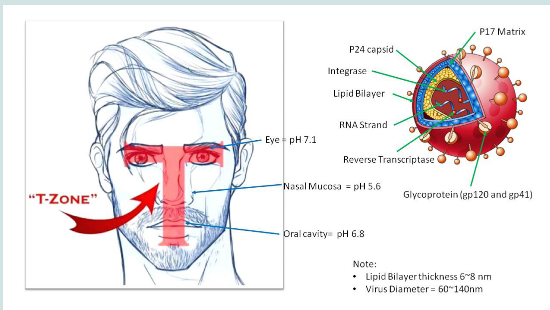

Figure 1:

ISSN: 2377-987X

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 Coronavirus 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.

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 to a selection of various culture medium of HIV-BaL viruses. They confirmed that 20% concentration of lime or lemon juice reduced the pH to 2.9, 90% of the viruses are inactivated in 2 min. When they observe the culture medium in a 10% concentration of lemon or lime juice (pH 3.4–3.7), only 50% of the viruses are inactivated in 2 min [10]. In further discussion, mentioned that a clinical trial on lemon juice or lime juice used for HIV treatment should be conducted ethically with an effective protocol to lower HIV spreading [8]. Furthermore, we can utilize these acidic fluids to test the activity of the novel Coronavirus (COVID-19) at a set range of temperatures (20 °C~37 °C) and in a duration time exposure to observe the outcome. This proposed experiment may eventually help to solve a low quantity of PPEs and disinfectants available in certain countries.

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.

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ISSN: 2377-987X

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Acknowledgement

MAS is a recipient of New Jersey Health Foundation Innovation Award. This publication is dedicated to the memory of Dr. H. Afsar Lajevardi [14] a legendry pediatrician (1953-2015). The views expressed in this paper are those of the authors and do not necessarily reflect the views or policies of the affiliated organizations. The authors hereby announced that they have had active cooperation in this scientific study and preparation of the present manuscript. The authors confirm that they have no financial involvement with any commercial company or organization with direct financial interest regarding the materials used in this study.