THE CHEMISTRY OF WASHING HANDS WITH SOAP AND THE USE OF HAND SANITIZER, AS MEANS OF PREVENTING THE INFECTION AND SPREAD OF COVID-19

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ABSTRACT

For now, there is no known cure for COVID-19 a novel contagious coronavirus disease, which broke out in 2019, and has continued to spread primarily between people through respiratory droplets from an infected individual due to sneezing or coughing and touching of infected surfaces. Therefore, maintaining proper hand washing and respiratory hygiene plays important roles in the fight against the spread of COVID-19. This paper seeks to look at the chemistry behind washing of hands with soap and the use of hand sanitizers as means of curbing the infection and its spread. The prevention guidelines reeled out by the World Health Organisation (WHO), demands the frequent washing of hands for nothing less than 20 seconds under running water or the use hand sanitizers amongst others. In Olabisi Onabanjo University, (75%) alcohol-basedhand sanitizer-OOUTIZER (WHO protocol) and OOU liquid hand wash soap (standard protocol) were prepared by the Department of Chemical Sciences for easy access by the University community. By this, the Department ensured that hand sanitizer to be used as a preventive measure was original.
In conclusion, from the certainty of materials used and the tests carried out, OOUTIZER produced is of good quality and suitable not just for the University community but also for the general public. The production of OOU liquid soap ensures the availability of soap for regular hand washing in the University. The production of both items from the Department of Chemical Sciences Laboratories is cost effective enabling the University to save cost.

Keywords: COVID-19, Sanitizer, liquid hand wash, prevention, chemistry
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Introduction

Coronaviruses (CoVs) are positively identified RNA viruses that are single-stranded belonging to the Orthocoronavirinae sub-family, Coronaviridae family in the order Nidovirales, consisting of four genera known as alpha, beta, delta, and gamma coronaviruses (WHO, 2020a). The wet Seafood wholesale market in Huanan, Wuhan, Hubei, China was where the disease first occurred as an enigmatic pneumonia associated with dry cough, occasional gastrointestinal symptoms, fever and fatigue in late December 2019 (Huang *et al*., 2020).The disease is transmittable from human-to-human largely from symptomatic people through respiratory droplets from coughing, aerosols and sneezing. The virus has an uncertain development time that varies with symptoms appearing from as early as 2 to as late as14 days after exposure (CDC, 2020). It has been observed that the disease could become infectious during the incubation period (Bai *et al*., 2020).Coronavirus Disease-2019 (COVID-19) became the official name given by WHO on February 11, 2020to the disease (WHO, 2020a). People from different age categories can be infected, however various evidences points to the fact that older people and those with fundamental medical situations are at a greater risk of contracting the severe COVID-19 disease, whereas other coronaviruses that are the reason for a substantial percentage of colds in grown-ups and children are not a severe danger for hale and hearty adults (OSHA, 2020; WHO, 2020a). Furthermore,

since no one has invulnerability to COVID-19, quite a huge number of people running to millions are probably going to be more liable to virus-relatedinfection and severe illness. Information from the WHO, as at 10th August 2020, showed that about 3.67% of cases reported to be infected with COVID-19 have died (WHO, 2020b).

From a total number (347,545) of people screened for COVID-19 cases so far in Nigeria, 48,770 were confirmed cases as at 15th of August 2020. Currently, Lagos State having a population of well over 20 million is leading with more than 16,456 established cases while Kogi state recorded the lowest casualty of 5 cases. Nine hundred and seventy-four (974) deaths have been recorded in the country while 36,290 cases have been discharged due to the fact that they have tested negative to the virus twice successively (NCDC, 2020; Worldometers, 2020).

Materials and Methods

Liquid hand wash soap was prepared with the following chemicals: Water, nitrosol (Labtech chemicals), Caustic soda (NaOH) (Qualikems Chemicals), soda ash (Na_2CO_3) (Qualikems Chemicals), Sodium lauryl sulphate (SLS) ($NaC_{12}H_{25}SO_4$) (Labtech Chemicals), texapon ($CH_3(CH_2)_{11}(OCH_2CH_2)nOSO_3Na$ (M & B Chemicals), sulphonic acid (H_2O_3S) (Sigma Aldrich), Sodium tripolyphosphate STPP ($Na_5P_3O_{10}$) (VWR Prolabo Chemicals), foaming booster (Romi Pure Chemicals), formalin (CH_2O) (M & B Chemicals), colouring agent, glycerine ($C_3H_8O_3$) (M & B Chemicals), perfume (M & B Chemicals), vitamin E ($C_{29}H_{50}O_2$).

The following procedure was used for the production (1001 Entrepreneurs, 2018) 62.5 g of caustic soda was allowed to dissolve in 2 L of water (A) and 125.0 g of soda ash was also allowed to dissolve in 2 L of water (B) and cooled being an exothermic reaction. While that is cooling, in a separate container, 1500 mL of sulphonic acid and 125.0 g of texapon were added together and stirred very well for 30 min (C) so as to homogenize properly. 125.0 g SLS was dissolved separately in 1000 mL distilled water (D) and so also was 65.0 g STPP (E) dissolved in 1000 mL distilled water. Then, 125.0 g nitrosol was dissolved in 10,000 mL of distil water (F) and stirred (it should dissolve immediately). Next add (C)+(F) = (W), (A) + (W)= (X), (B) + (X) = (Y), then add (D + E) + (Y) = (Z), formalin is then added to (Z) followed by adding foam booster and vitamin E. Dissolve the colourant of choice in water, mix thoroughly, add to (Z) and stirred vigorously. This is allowed to stand for 5 h and then packaged.

Water acts as the main solvent needed for the dissolution of the various ingredients during the fermentation stage. Nitrosol is the thickening agent used for liquid soap production. Caustic soda is the stain/dirt removing agent, because it is usually corrosive to the skin, soda ash is used to regulate its concentration by neutralizing it. SLS is the main foaming agent, a surfactant which helps to lower the surface tension of the aqueous solution. Texapon serves as a foaming agent and a foam booster. Suphonic acid is a foaming and cleaning agent that boosts the performance of SLS. STPP is a strong cleaning agent and also helps SLS to work to its full potential. Formalin is used as a preservative. The perfume gives the soap a sweet fragrance, glycerine used helps the skin to remain hydrated and soft after using the soap, while vitaminE protects the skin and prevents wrinkles (1001 Entrepreneurs, 2018).

OOUTIZER was prepared with the following chemicals using the isopropyl formulation: water, analytical reagent grade isopropyl alcohol (C_3H_8O) from BDH, England, glycerol ($C_3H_8O_3$), hydrogen peroxide (H_2O_2), colouring agent and fragrance.

World Health Organisation recommended two different procedures for the preparation of hand sanitizers that are alcohol-based (WHO, 2009).

Ethyl alcohol-based: For the production of a 1 L volume hand sanitizer containing 80% ethyl alcohol v/v, 1.45% glycerol v/v, 0.125% hydrogen peroxide (H_2O_2) v/v in the final concentrations: ethanol (833.3 mL), hydrogen peroxide (41.7 mL), glycerol (14.5 mL) were all measured and poured into a 1 L standard flask. The flask is topped up to the 1L mark with boiled cooled water or distilled water and shaken gently to mix the content.

Isopropyl alcohol-based: For the production of a 1 L volume hand sanitizer containing 75% isopropyl alcohol v/v, 1.45% glycerol v/v, 0.125% hydrogen peroxide v/v: isopropyl alcohol (751.5mL), hydrogen peroxide(41.7mL), glycerol (14.5 mL) were all measured and poured into a 1 L standard

flask. The flask is topped up to 1 L mark with boiled cooled water or distilled water and shaken gently to mix the content.

The isopropyl alcohol is measured into a container having the specified graduated mark to be prepared. With the aid of a measuring cylinder, the specified volumes of hydrogen peroxide and glycerol are added. Due to the high viscosity of glycerol, it does not all come off the measuring cylinder and can be removed by adding some already cooled boiled water which is then poured into the container. The mixture is then topped up with the remaining cooled, boiled water to the desired corresponding mark to be prepared.

The solution is mixed by gentle shaking, after which the lid of the container is immediately placed to avoid evaporation, then kept in quarantine for 72 h. The quarantine period allows time for H_2O_2 to remove any microorganisms found in the isopropyl alcohol or in the fresh or reused packaging containers.

The active component in the formulation is the isopropyl alcohol, while H_2O_2 included in the formulation at a low concentration is to help remove microorganisms that can cause infections in the unpackaged solutions and excipients. Glycerol acts as an emollient which protects the hands' skin against dryness and dermatitis, to increase the acceptability of the product and also because it is safe and relatively inexpensive. A colourant is added to differentiate the hand rub from other fluids (WHO, 2006; WHO, 2009).

Prevention of COVID-19

The first line of approach is proactive preventive methods by pursuing the strategic objectives of the WHO: disrupt the spread from animals to humans and human-to-human plus decreasing ancillary infections among health care personnel and other close associates, stopping transmission by unceasing observation, separation and rapid care for patients; dealing with vital unknowns concerning medical severity, and improvement of diagnostics; sharing information about significant hazards to all groups of people and contradict untrue information in circulation. Significant community health schedules need to be taken as well as follow-up of associates, infection deterrence and management in health care facilities, execution of health schedules for travellers, and increasing consciousness among the general public (WHO, 2020).

Mutual precautionary measures must be firmly adhered to, with observance of good respiratory hygiene, washing of hands with any type of soap (not necessarily antibacterial), use of alcohol-based hand sanitizer, restriction of movement into and out of diseased areas apart from out of requirement. In addition, just like other viruses, SARS-CoV-2 can be incapacitated with about 70% concentration of isopropyl alcohol and ethyl alcohol aside from 0.1% sodium hypochlorite within one minute of contact (Kampf *et al*., 2020).

Structure of Coronavirus and Soap

Frequent washing of hands with any type of soap is among the WHO-recommended precautionary actions against infection and spread of COVID-19 (WHO, 2020c). Hence it is important to look at the structure of coronavirus and how soaps provide distinctive chemical properties that can sterilize the virus entirely. Coronavirus is an enclosed, positive one-strand RNA virus belonging to the subfamily Orthocoronavirinae, having the typical "crown-like" spines on their exteriors (Perlman, 2020). Coronavirus has a coating of double-layeredoily lipid particles, covered with proteins that help the virus contaminate cells (Corum and Jabr, 2020). Firmly lodged into the coating are no fewer than three virus-related proteins: the glycoprotein spike forming the protrusions on the entire virus particle, giving the virus its crown-like form and structure; the membrane protein, the most copious structural protein, and the small envelope protein, with no affinity for water, while in addition, some coronaviruses also have an extra membrane protein called hemagglutinin esterase (Hogue and Machamer, 2008). The double layers of oily lipid molecules have both a polar (phosphate) head covalently bonded to a non-polar (lipid) tail around the virus playing a key role not only in contaminating the host cell but also in deactivating the entire virus (Tripet *et al*., 2004).Washing of hands with soap and water is a sure way to remove many microorganisms, as well as the novel Coronavirus (Jabr, 2020). Soaps are chemically, the sodium or potassium salts of long-chain fatty acids (saturated or unsaturated) that works as surfactant molecules by lowering the surface tension of water (Wolfrum *et al*., 2016); the long hydrocarbon chain end forming a non-polar tail and the ionic

carboxylate group end forming a polar head (Hill and Moaddel, 2016). The surfactant molecules (Figure 1) are soluble in water, thus, in an aqueous medium, the non-polar tail interacts actively with the non-polar ends of oil, grease, dirt, and even virus particles. Consequently, the cleaning effect of soap is credited mostly to the surfactant molecules existing in the soap.

Mechanism of soap action on Coronavirus

One of our most effective defences against unseen pathogens is soap, with just a very small amount of regular soap in water being adequate to split and destroy numerous kinds of microorganisms, not excluding the novel Coronavirus presently ravaging the world. The key to the overwhelming strength of soap might be its hybrid structure, with its cleaning action based on the chemical principle of like molecules dissolves each other. Looking at the structures of both the coronavirus and soap there are similarities which allow them to interact together based on like dissolves like.

There are about three main mechanisms by which soap works against the SARS-CoV which causes COVID-19: simple elution mechanism, Membrane rupture mechanism and Viral entrapment mechanism. We shall focus on the simple elution mechanism here (Contreras *et al*., 1999; Shahid *et al*., 2009).The external lipid layer of Coronavirus and other enclosed viruses allows their attachment as a thin film on the host cell exterior (Bitton, 1975). The force of attraction between the non-polar ends of soap with non-polar lipid membranes, supports the attachment of soap molecules. The resulting solution from mixing soap and water, has a very low surface tension thereby forming very thin layers by which they go into minute spaces and extend effortlessly round the dirt particles, as well as viruses (Lambers *et al*., 2006). Fig. 2 shows how soap terminates the virus when its molecules' non-polar tails wedge into the lipid film and breaks it apart. Soap holds on to dirt and pieces of the damaged virus in small soap suds, which can then be rinsed away in water (Corum and Jabr, 2020).

Hand sanitizer and Coronavirus

Frequent use of hand sanitizer is again one of the preventive measures announced by WHO to curb the infection spread amongst others. In the event of soap and water not being accessible, using a hand sanitizer having not less than 60 percent alcohol in its contents could be helpful, advised the CDC. The CDC recommends a 60 percent alcohol sanitizer, so be careful about sanitizers in the market place falling short of this standard (or not having any alcohol). Hand sanitizer although helpful, can fail when not properly handled. If you use the sanitizer when your hands are greasy, wet or sweaty, it can become diluted thus reducing its efficacy. Hand sanitizer having above 60 % alcohol is effective against Covid-19 and is a good alternative when you can not access water, you are in transit or you need to quickly get your hands clean after contact with any potentially infectious surfaces. Not all alcohols can be used to prepare hand sanitizers and under no account must methanol commonly referred to as wood alcohol be used because it is a substance that can be harmful when absorbed or ingested through the skin and that can be life-threatening when ingested. Ethanol and isopropyl alcohol are good for hand sanitizer production; however, isopropyl alcohol is better because as soon as alcohol concentrations fall lower than 50%, disinfection effectiveness reduces sharply while higher concentrations of alcohol do not produce additional desired virucidal, bactericidal, or fungicidal effects. This is because water is vital in the destruction or inhibition of the development of disease-causing microorganisms with isopropyl alcohol. Water serves as a catalyst playing a major role in denaturing the proteins of vegetative cell membranes. Seventy percent solution of alcohol infiltrate the cell wall more totally which infuses the whole cell, congeals all proteins, thus leading to the death of the microorganism. Additional amount of water reduces the rate of evaporation, thereby allowing for more time of surface interaction and improving efficiency (Rutala and Weber, 2020).

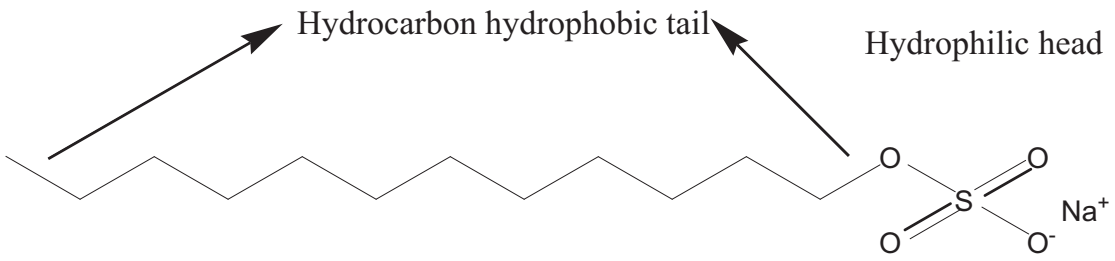

Fig. 1: Surfactant molecule Sodium- Lauryl sulphate (SLS)

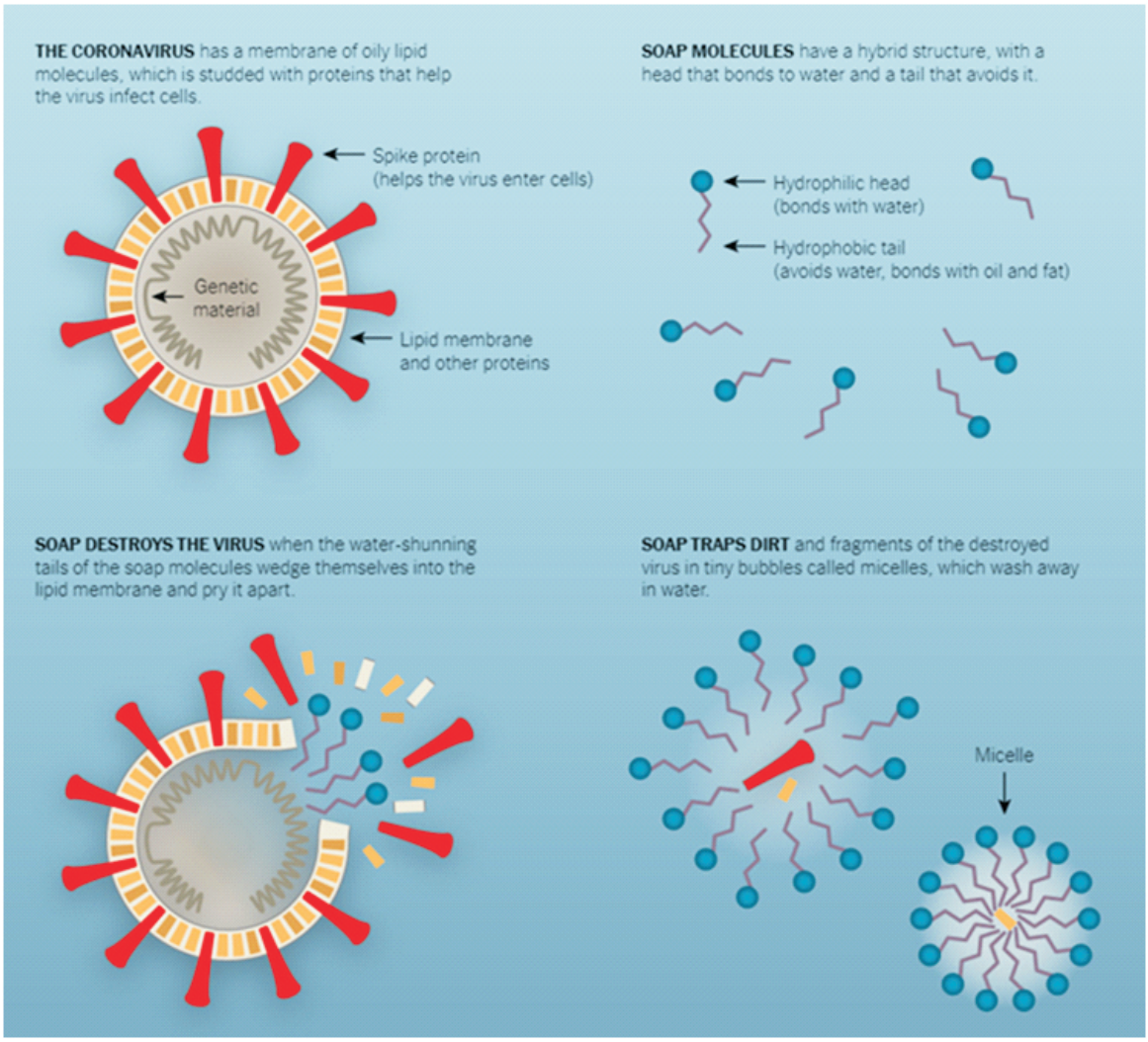

Fig. 2: The destructive action of soap molecule on dirt and the coronavirus membrane
Photo Credit: Corum and Jabr (2020)

Conclusion

This paper concludes that prevention is the way to go as regards COVID-19 particularly as it seems that the carriers here in Nigeria are majorly asymptomatic. The wearing of face masks in communal places certainly prevents the movement of droplets from nose and mouths from one person to the other, while the use of hand sanitizer or washing of hands regularly with soap breaks through the structure of the virus leading to its disintegration. Water alone can clean off dirt to some extent, but disease-causing microorganisms are so tiny that they frequently need chemical and mechanical interference to remove their sticking nano particles from the tiny characteristic cracks in our special fingerprints. Hence, soap is of utmost necessity, and allowing it a minimum of 20 seconds of vigorous scrubbing, enables its pointed-shaped particles to enter the types of microorganisms, including COVID-19, which are protected by an oily lipid membrane.

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