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Clinical Comparative Study of Herbal Based and Synthetic Based Hand Sanitizer in COVID-19 Pandemic

Priyanka Lokhande[1], Aarti Khule[1], Prashant Vyavhare

1. *Student Matoshri College of Pharmacy, Eklahare, Nashik-422010, India*
2. *Student Matoshri College of Pharmacy, Eklahare, Nashik-422010, India*
3. *Professor, Pharmacology Department, Matoshri College of Pharmacy, Eklahare, Nashik-422010, India*

ABSTRACT:

Hand cleanliness is critical in preventing the spread of infection. It is the most crucial component of infection control efforts. Hand hygiene is defined as hand cleaning with soap and water or using a hand sanitizer to cleanse hands and nails. Alcohol hand gels should have a minimum alcohol content of 60% to be effective. Hand washing is required in the food production and service industries, as well as in hospital settings. COVID19 is a virus that spreads through droplets of saliva or nasal discharge from an infected person's coughing or sneezing. The most common way of infection transmission is from person to person. As a result, maintaining good hand hygiene is critical in order to avoid illness. According to various studies, hand sanitizers can eradicate 99.9% of bacteria on hands. Hand sanitizer is a liquid gel or foam that is used to kill viruses, bacteria, and microbes on the hands. Hand sanitizers can stop bacteria and diseases from spreading from one part of our body to another. Hand sanitizers can stop bacteria and diseases from spreading from one part of our body to another. Hand sanitizer eliminates harmful microorganisms on the hands' surface.

Keywords: Hand hygiene, hand sanitizer, infections, microorganisms, COVID 19, herbal, alcohol based.

INTRODUCTION

In December 2019, the Coronavirus Disease 2019 (COVID-19) outbreak began in Wuhan. The capital of Hubei province in mainland China, and was caused by a novel coronavirus [severe acute respiratory syndrome coronavirus 2 (SARS-COV-2). On January 30, 2020, the

World Health Organization (WHO) proclaimed the COVID-19 epidemic a public health emergency of international concern, citing more than 271 million confirmed cases, 5 million deaths, and 8 billion vaccines as of December 16, 2021[2]. Interventional strategies such as wearing a mask, maintaining hand hygiene, and social distancing remained critical in the absence of standardized medical treatment, and were instrumental not only in slowing the spread of COVID-19 but also in reducing the risk of other respiratory infectious diseases [1].

Hand cleanliness is crucial in preventing the spread of viral infections like Covid-19. The proper hand washing and drying approach breaks the chain of fatal disease transmission from a contaminated surface/site to the hand and other areas of the body [8]. Hand hygiene should be maintained by washing hands often with soap and water for at least 20 seconds to 30 seconds [1]. It's vital to interrupt the virus's transmission cycle, especially in cases like a pandemic epidemic, by using adequate hand sanitization. Contact isolation and tight infection control methods, such as maintaining good hand cleanliness in hospital settings and in public, can help achieve this. Hand sanitization relies on the use of effective hand disinfectants, which come in a variety of sorts and forms.

Hand-washing is essential in the food service industry, as well as in healthcare settings, households, and day care settings. Despite the fact that good and simple hygiene techniques are the single most important, easy, and least expensive means of preventing health-related infections and the spread of antimicrobial multidrug resistance, hygiene practices are unfortunately still observed due to a lack of scientific knowledge, awareness of risks, and hygiene facilities[36].

Hand sanitizer

A liquid gel or foam that destroys viruses, germs, and microorganisms on the hands is known as hand sanitizer [4]. According to the World Health Organization, "an alcohol-containing solution (liquid, gel, or foam) is developed for application to the hands to inactivate bacteria and/or temporarily inhibit their growth" (WHO). There may be one or several varieties of alcohol, additional active substances with excipients, and humectants may be present in such preparations"[5,6]. Hand sanitizers were first used in healthcare settings in 1966 and were widely popular in the early 1990s [5,7].

When to use?

- When soap and water are not available.
- When your hands aren't greasy or filthy.
- Hands should be sanitized when in direct touch with patients.
- Sanitize your hands before putting on sterile gloves.
- Hands should be sanitized before placing a central intravascular catheter.
- Hands should be sanitized before undertaking medical procedures that do not involve surgery, such as putting indwelling urinary catheters, peripheral vascular catheters, or other invasive devices.
- Before taking the pulse or blood pressure, wash your hands.
- Sanitize hands when they come into contact with bodily fluids or excrement, mucous membranes, non-intact skin, or wound dressings, even if they are not obviously filthy.
- They should clean their hands after coming into touch with objects (including medical equipment) in the immediate proximity of the patient.
- Hands should be sanitized after removing gloves [9,5].

Type of hand sanitizers

Hand sanitizer is separated into two categories: alcohol-based and alcohol-free. An ABHS may contain one or more types of alcohol, as well as various excipients and humectants, to be applied to the hands to kill microorganisms and inhibit their growth temporarily [3]. Without the use of water or towel drying, ABHS can effectively and quickly reduce germs throughout a broad germicidal range. Despite this, ABHS has a few drawbacks, including a brief antibacterial action and limited effectiveness against protozoa, some (non-lipophilic) viruses, and bacterial spores [3,10].

The antimicrobial effects of the alcohol-free sanitizer, on the other hand, are achieved by the use of compounds with antiseptic qualities. According to their chemical functional groups, these compounds have various modes of action [11,12]. They are safer to use among children than ABHS because they are fire resistant and frequently used at low doses. ABHS comes in a variety of dose forms, including gel, liquid, and foam. Because each variety has its own traits [13, 14].

Alcohol based hand Sanitizer:

Fig.1. Alcohol-Based Sanitizer

Alcohol-based hand sanitizers kill bacteria, virus, fungi, and other microorganisms without the need for wet additives because it dries up microorganism growth with optimal efficacy [15,18,19]. Hand sanitizers based on ethanol are effective at inactivating encapsulated viruses like COVID-19 strains [20,21]. The concentration of isopropyl alcohol in WHO-recommended formulations ranges from 60 to 90 percent, and it has antibacterial, antiviral, and antifungal properties (World Health Organization (WHO) 2020b). Within 15 seconds of contact time, isopropanol at concentrations ranging from 62% to 80% can inactivate high titers of human coronavirus dried on solid surfaces. [22]

WHO recommends an alcohol-based formulation because of following reasons:

- to gain access to sinks or other facilities to perform hand cleansing actions that require the use of water; to reduce the annual cost of hand hygiene promotion including recourse
- to overcome the absence of access to sinks or other facilities for performing water-based hand washing procedures
- to overcome the lack of accessibility to sinks or other facilities to perform hand cleansing actions that require the use [15,16,17]

Non-Alcohol Based Hand Sanitizer:

Fig.2. Nonalcoholic-Based sanitizer

Disinfectants such as soap and synthetic detergent are commonly used to prevent the spread of coronavirus [34,35]. To kill microorganisms, alcohol-free sanitizers use quaternary ammonium compounds (benzalkonium chloride) instead of alcohol. These substances are not as effective as alcohol. Alcohol-free hand sanitizers do not cause your hands to get dry. After rubbing their hands together, they produce a small amount of foam. They don't have any scent. Water-based foam sanitizers are the most common alcohol-free sanitizers. Many alcohol-free sanitizers have a 0.1 percent concentration of Benzalkonium, with the balance of the solution consisting primarily of water, skin conditioner, and vitamin E for moisturizing. There are fewer fire concerns, and it is non-damaging to surfaces. [65]

Advantages of Alcohol Based Hand Sanitizer:

1. Sanitation: One of the most important advantages of hand sanitizer is that it sanitizes. It's intended to get rid of germs, and you should pay heed to that. Hand sanitizers, when used properly, can eliminate 99.9% of germs on your hands [61].

2. Portability: You can't take a sink with you everywhere you go. Soap and water aren't always going to be available in situations where you'll need to scrub your hands. A teeny-tiny amount of hand sanitizer will find its way into your compartment, tote, or pocket. It's also great for when you've had a bite at a game or just left a public area like the market [61].

3. Reduces Illness Risk: Especially during influenza season, limiting your exposure to other people's germs is critical to your health. Every time you take a break during the day, you minimize your chances of being ill. Even a quick trip to a friend's house or the store might expose you to germs that can cause a cold, flu, or a variety of other ailments, so keeping your hands as clean as possible is critical [61].

4. Encourage good hygiene and health: according to studies, one out of every five people does not wash their hands frequently. Seventy percent of United Nations organizations do not use soap. The presence of hand sanitizer in crucial areas (such as restrooms and kitchens) gives the impression that people can use it to kill hazardous bacteria [61].

5. Reduce Waste: As a precaution, many of us can use paper towels to open doors once we've exited the restroom or kitchen. Individuals can easily defend themselves against pathogens by placing hand sanitizers near exits without making any additional mess [61].

Adverse effects of alcohol based hand sanitizers:

1. Dries out your skin: Alcohol is an effective antiseptic, which means it has been tested for the ability to kill germs and viruses on organic surfaces. Alcohol, on the other hand, is known to have a drying effect on the skin. When you use hand sanitizer on your hands numerous times a day, the product absorbs moisture from your skin. This may cause skin to become dry, flaky, and sensitive to touch [43].

2. Can cause a skin disorder breakout: As hand sanitizer dries on your hands, restless and red or discolored skin disorder spots appear. This is because if you have a skin condition, the chemicals will aggravate your symptoms [43].

3. Has the potential to affect your hormones: Most hand sanitizers contain a chemical known as triclosan. Triclosan is a bacteria-killing agent that has been used in products ranging from dentifrice to body wash, according to the FDA Trusted source. According to the Food and Drug Administration, several studies have found that high levels of triclosan can alter natural internal secretion cycles and even affect fertility [43].

4. Can contribute to antibiotic resistance: According to the FDA trusted source, triclosan is supposed to kill bacteria, but its usage in consumer products is also contributing to the rise in antibiotic-resistant bacteria [43].

Herbal Based Hand Sanitizer:

Fig.3. Herbal Based Sanitizer

Hand sanitizer with herbs Lemongrass, neem, lemon, and tulsi are among the herbs used. The antibacterial, fungicidal, and antimicrobial qualities of this herbal sanitizer aid to keep viruses, germs, and fungus at bay. This sanitizer contains Tulsi essential oil, a powerful natural antibacterial ingredient, as well as 60 percent isopropyl alcohol, which kills germs. The product's powerful germ-killing activity has been clinically proven. Flavonoids, alkaloids, and polyphenolic chemicals found in indigenous medicinal plants have antiseptic, disinfecting, and antibacterial properties. Plant extracts were employed as potent antiseptics and disinfectants to kill germs in the past. We intended to provide herbal formulations and preparations for free hand sanitizers based on indigenous medicinal plants that have shown to be efficient against pathogenic bacteria while having the least damaging effect on the environment [58,59].

Advantages of herbal hand sanitizer:

1. The painful stinging sensation: We're all too familiar with that painful stinging sensation after we make the mistake of using hand sanitizer when our cuticles are losing their skin, or if we have dry, cracked hands throughout the colder months of the year (paradoxically creating them even drier as they strip oils off your skin). This is because old, alcohol-based hand sanitizers include alcohol. Herbal hand sanitizers, on the other hand, do not irritate the skin and often contain elements that help to create a healthier, softer complexion [60].

2. Improve skin condition: In the case of oil-based sanitizers, however, flavored hand sanitizers invariably contain some oil or succulent gel to help maintain & improve skin condition and even moisten dry hands. [60]

3. Non-flammable: One of the most concerning aspects of alcohol-based sanitizers in terms of safety is the possibility for abuse or injury due to accidents. Many people, particularly children, have suffered burns as a result of sanitizer overuse since they aren't aware of the dangers of transferring open flames to the point of anyone using the sanitizer. This risk has prompted some public locations to switch to flavored hand sanitizers, particularly for usage in patient rooms, hallways, and public areas [60].

4. Natural pleasant odour: The odour of alcohol is distinct, and many people are aware that it is offensive. This usually necessitates the addition of a number of compounds known as esters to your hand sanitizers simply to make the smell pleasant enough to use. Some flavored sanitizers still employ perfumes and chemical aromas to enhance their smell and make them more appealing to users, but these days they've shifted to a lot of natural chemicals as people have gotten more sensitive to the dangers. Finally, essential oils have their own natural & pleasant smelling smells, and our exclusive formulations blend fragrance with performance, ensuring you get the best of both worlds [60].

5. Residual protection: Did you know that alcohol-based hand sanitizers lose their effectiveness as soon as their concentration falls below a specific threshold, i.e. as soon as a significant portion of it is gaseous off your hands? The protection provided by an alcohol-based sanitizer lasts for as long as you can feel it on your skin before it evaporates. In contrast, flavored hand sanitizers, particularly oil-based ones, allow antibacterial drug oils to enter the skin, allowing for a longer-lasting and deeper cleansing effect [60].

Disadvantages of herbal hand sanitizer:

1. Alcohol-based hand sanitizers are less effective than herbal hand sanitizers [5].

2. Many studies conducted by healthcare centers have revealed that herbal sanitizers may not be effective against all forms of germs, bacteria, and viruses [5].

3. Products containing less than 60% alcohol are less effective at killing bacteria and fungi, and may just slow down rather than kill germs [5].

Pharmaceutical ingredients used in hand sanitizer preparation and their function:

Alcohol Based

Plant product ABHS contains alcohol, as well as n-propanol. The best germicidal activity is claimed to be at a concentration of 60–95 percent alcohol by volume. The ability of alcohols to break down lipid membranes and denature microorganism proteins contributes to their antibacterial properties. Most vegetative bacteria, fungi, and ingested viruses (including eubacteria tuberculosis) are susceptible to the antibacterial actions of alcohols (human immunological disorder virus [HIV] and herpes simplex virus). However, they are ineffective against microbe spores, which are the most frequent microbes found in raw materials [1].

1. Alcohol: The ideal concentration of alcohol in hand sanitizer is 60-90 percent [11,12]. By attacking the cell structure of pathogens like bacteria, alcohol (-OH) denatures macromolecules and lipoid membranes, rendering them inert. As a result, the virus can no longer harm people [23,24]. E.g. Ethanol, Isopropanol.

2. Hydrogen peroxide: The low concentration of H2O2 is used to help remove contaminated spores from bulk solutions and receivers, but it isn't a strong antisepsis agent. H2O2 provides an important safety feature, but its corrosive nature and difficult procurement in some countries make it impossible to use 3–6% for the assembly. More research is needed to analyse H2O2 availability in various nations, as well as the risk of using a stock solution with a lower concentration [25].

Non-alcohol Based ingredients:

1. Chlorhexidine: Antiseptic antibacterial activity appears to be caused by their adherence to living material membranes and subsequent rupture, resulting in cellular content precipitation. Chlorhexidine has a slower initial antibacterial effect than alcohols. It works well against gram-positive bacteria, a little less well against gram-negative bacteria and fungi, and has the least effect on mycobacteria [27,28,29]. [27,30,31,32,33] Chlorhexidine has persistent effects. Antiseptics added to alcohol-based therapies at low concentrations (0.5–1%) give much higher residual effect than alcohol alone. When used as indicated, antiseptic has a strong safety record [27,29].

2. Chloroxylenol: As a preservative in cosmetics or as an antibacterial agent in soap, chloroxylenol is a common ingredient. Chloroxylenol's antibacterial effect is due to its capacity to deactivate accelerator systems and affect microbe cytomembrane production.

It's effective against bacteria and absorbed viruses, but not so much against bacteria of the species Aeruginosa [3,34,35].

3. Iodide (Iodophors): Since the 1800s, iodine has been utilized as a good antiseptic for skin medical treatment. It will penetrate the cytomembrane of the bacterium and form compounds with amino acids or unsaturated fatty acids to prevent cellular components from being synthesized. Combining iodine with a variety of polymers improves iodine solubility, facilitates long-term iodine release, and decreases skin irritation. Antiseptic activity of iodine and iodophors against gram-positive, gram-negative, and spore-forming bacteria (clostridia, Bacillus spp.) as well as mycobacteria-ria, viruses, and fungi[35, 36].

4. Quaternary ammonia Compounds: Quaternary ammonia compounds are made up of an atomic number 7 atom attached to four alkyl radical teams, and their structure and complexity can vary greatly. Quaternary ammonia compounds are largely organic processes and fungi static; they're microbicidal against some species at high quantities, though. In comparison to gram-negative bacteria, gram-positive bacteria are more active. Handwashing with traditional soap and water was about as effective as using antimicrobial wipes containing a quaternary ammonia compound. According to a recent clinical research among surgical critical care unit HCWs [34,35], both of these methods were significantly less efficient than decontaminating hands with an alcohol-based hand rub.

5. Triclosan: The nonionic insecticide triclosan (chemical name 2,4,4'–trichloro-2'-hydroxydiphenyl ether) was developed in the 1960s. Molecules without colour. It's been used in HCW and general public soaps, as well as a number of other client products. Antimicrobial activity can be detected at concentrations as low as 0.2 percent and as high as 20%. It kills gram-positive bacteria such methicillin-resistant Staphylococcus aureus, as well as fungi and mycobacteria [35, 36].

Excipients:

1. Glycerol: Glycerol is used as a humectant to improve the product's acceptability [25]. The use of glycerol as an emollient is intended to keep the hand skin from drying out and developing dermatitis as a result of repeated use [26,27]. Glycerol was chosen since it is both safe and reasonably priced. The proportion of glycerol in the hand rub should be reduced further to reduce stickiness [25].

2. Essential oils: Flavoring agent, antibacterial, antiviral, antimicrobial, and antiseptic properties [25, 26].

3. Fragrance: Aesthetic, allowing fluids to be distinguished from one another. Because of the possibility of allergic responses, adding perfumes is not recommended [27].

Herbal plants used in preparation of hand Sanitizers:

1. Tulsi:

Tulsi is an aromatic woody plant in the basil family Labiatae (tribe ocimeae) that is native to the Japanese world tropics and is said to have originated in north central India. [48].

Fig.4. *Ocimum sanctum*

Tulsi has antibacterial, antiviral, and antifungal activity against a variety of microorganisms that cause human diseases, according to modern research [49]. Antimicrobial properties of Tulsi have been tested against E. coli, Klebsiella, candida, cocci aureus, Enterococcus faecalis, and Proteus. The therapeutic effect of tulsi is primarily due to O. sanctum. Talsi's antimicrobial properties are due to its components, ursolic acid and carvacrol. [50,62,63,64].

2. Neem:

Fig.5. *Azadirachta indica*

Arishth leaves (A. indica or AI) are known to offer medicinal, antifungal, antiviral, inhibitory, medicinal, antipyretic, and analgesic properties with no side effects. Many active ingredients in AI are responsible for its pharmacological activity, including nimbidin, nimbin, nimbolide, gedunin, organic compound, mahmoodin, margolone, and cyclic trisulfide. The most significant reduction in E. faecalis adhesion to dentin is caused by AI [51].

3. Turmeric:

Fig.6. *Curcuma longa*

Turmeric's ethanolic extract has antibacterial properties, stopping germs including Pseudomonas aeruginosa, Bacillus cereus, and Proteus mirabilis from growing. Trichophyton longifusus is an antifungal contender as well. When applied externally, curcumin has been shown to decrease variegation and the onset of skin malignancies. [52]. Turmeric, an ancient Asian colouring spice and the main source of curcumin, has been used for a range of ailments for a long time [53].

4. Aloe Vera:

Fig.7.*Aloe vera*

A variety of methods have been used to demonstrate the effect of Aloe Vera inner gel against Gram-positive and Gram-negative bacteria [54]. Aloe vera gel has been shown to inhibit Streptococcus pyogenes and Streptococcus faecalis bacteria [55]. Pseudomonas aeruginosa was bactericidal in aloe vera gel and was inhibited from adhering to human lung epithelial cells in a monolayer culture by acemannan [56].

5. Lemon juice:

Lemon is a rosid dicot plant that is extremely beneficial to one's health. Lemon's many parts (leaves, stem, root, and flower) are cultivated largely for their alkaloids, which have malignant neoplasm activity and also have medicinal promise in crude extracts against clinically significant microorganism strains.

Fig.8.*Citrus Lemon*

Citrus flavonoids are responsible for biological actions such as medicament, antifungal, medicine, malignant tumors, and antiviral. They function as direct antioxidants and radical scavengers, as well as modulators of protein activity and inhibitors of cell proliferation.

They appear to perform a defensive role in plants against offensive diseases, microorganisms, fungus, and viruses [57].

SURVEY: In COVID19 pandemic we all used Hand sanitizers for prevention and spreading of infection. So we did a survey on Herbal sanitizer and synthetic hand sanitizer. 100 people participated in this survey. Data has been collected and analyzed.

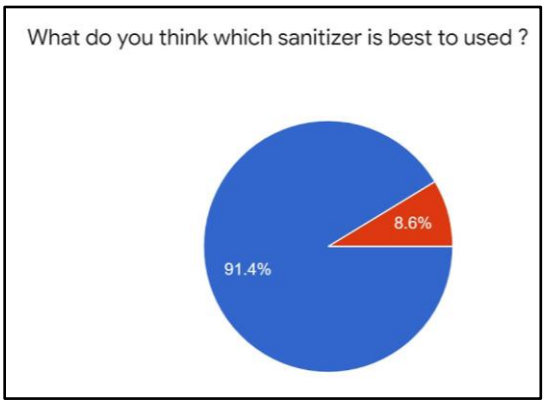

Fig.9. Pie chart showing the responses collected for the question that which sanitizer is best to use in pandemic condition, 91% population goes with herbal and 9% population goes with synthetic hand sanitizer

Conclusion:

Hand cleanliness was considered the most important protective step during the COVID-19 epidemic. Alcoholic hand sanitizers, which are recommended by the WHO, have been found to be hazardous to the environment and human health. Hand hygiene is a must for COVID-19; hand sanitizers, especially when outside, will suffice. When compared to alcoholic hand rubs, alcohol-free and herbal hand sanitizers are simple to make and provide greater effects. Hand sanitizers made from readily available herbal plants with precise efficiency in reducing microbial load from hands.

Hand sanitizer can be made with the alcohol content, non-alcoholic content and herbal ingredients by going through the detailed study of hand sanitizer. It was proven that herbal hand sanitizer has the less allergic condition and more beneficiary use as compared with synthetic hand sanitizer.

Reference:

1.Elvis.S.,Almi.B.,Shanmitha.A.,Biswanath.M.; Unravelling the Enigma of Hand Sanitizer in COVID-19-A Bibliometric Analysis o Related Publications Over the Year; *Research Square;* May 2021; 1-2: https://doi.org/10.21203/rs.3.rs-526772/v1

2. COVID-19,Coronavirus Update live,Available online:http://covid19.who.int/ ;(Accessed on 17 Dec 2021).

3. Jing, J. L. J., Pei Yi, T., Bose, R. J. C., McCarthy, J. R., Tharmalingam, N., & Madheswaran, T. (2020). Hand Sanitizers: A Review on Formulation Aspects, Adverse Effects, and Regulations. *International Journal of Environmental Research and Public Health*, 17(9), 3326. https://doi.org/10.3390/ijerph17093326

4. Maheshwari S.Bhoge,Shamalila B.Bavage,Nandkishor B.Bavage; Evaluation and Formulation of Herbal Hand Sanitizer; *International Journal of Research publication and Review ISSN 2582-7425; 2*(10);Oct 2021; 784-786.

5. Pallavi S.,Ipshita P.,Shitanshu M.,Himangi D.,Himanshu C.;Hand Sanitizer as Alternative to Hand Washing- A Review of Literature; *Journal of Advanced Oral Research;11*(2); 2020; 137-142.

6. Greenaway RE, Ormandy K, Fellows C, et al. Impact of Hand Sanitizer Format (gel/foam/liquid) and Dose on its Sensory Properties. J Hosp Inf 2018; 2: 411–416.

7. Pittet D. Improving Adherence to Hand Hygiene Practice: A Multidisciplinary Approach. Emerg Infect Dis 2001; 7: 234–240.

8. Nandkishor S.Wani,Ashish K.Bhalerao,Vikram P.Ranaware,Rahul Z.; Formulation and Evaluation of Herbal Sanitizer;*International journal of Pharma tech Research; 5;* Jan-Mar 2013; 40-43.

9. Curtis V. Talking dirty: How to Save a Million lives. Int J Environ Health Res 2003; 13(Suppl 1): S73–S79.

10. Gold, N.A.; Avva, U. Alcohol Sanitizer; StatPearls Publishing: St. Petersburg, FL, USA, 2018.

11.Mcdonnell G.,Russell A.D.; Antiseptic and Disinfectant: Activity, Action and Resistance. Clic. Microbial. Rev 1999 ,12, 147- 179.

12. Bloomfield, S.F.; Arthur, M. Mechanisms of Inactivation and Resistance of Spores to Chemical Biocides. J. Appl. Bacteriol. 1994, 76, 91S–104S.

13.Visscher, M.; Davis, J.; Wickett, R. Effect of Topical Treatments on Irritant Hand Dermatitis In Health Care Workers. Am. J. Infect. Control 2009, 37, e1–e842.

14. Winnefeld, M.; Richard, M.A.; Drancourt, M.; Grob, J.J. Skin Tolerance and Effectiveness of Two Hand Decontamination Procedures in Everyday Hospital use. Br. J. Dermatol. 2000, 143, 546–550.

15. World Health Organization (WHO) WHO Guidelines on Hand Hygiene in Health Care (Advanced Draft). World Alliance for Patient Safety . Global Patient Safety Challenge,2005-2006,"Clean Care is Safe Care" 46-47.

16. Boyce JM, Antiseptic Technology :Access , Affordability,and Acceptance, Emerging Infectious Disease, 2001, 7; 231-233.

17. Pittet D et al.; Cost Implication of Successful Hand Hygiene Promotion, Infection Control and Hospital Epidemiology; 2004; 25: 264-266.

18. Larson EL et al.Efficacy of Alcohol Based Hand Rinses Under Frequent Use Conditions, Antimicrobial Agents and Chemotherapy; 1986, 30: 542-544.

19. Larson, E.L.; Aiello, A.E.; Bastyr, J.; Lyle, C.; Stahl, J.; Cronquist, A.; Lai, L.; Della-Latta, P. Assessment of Two Hand Hygiene Regimens for Intensive Care Unit Personnel. Crit. Care Med. 2001, 29, 944–951.

20. Kantor, J., Philadelphia, M., & Augustine, S. (2020). Behavioral Considerations and Impact on Personal Protective Equipment Use: Early lessons from the Coronavirus (COVID-19) Pandemic. Journal of the American Academy of Dermatology, 82(5), 1087–1088. https://doi.org/10.1016/j.jaad.2020.03.013

21. Kenters, N., Eikelenboom-Boskamp, A., Hines, J., McGeer, A., Huijskens, E. G. W., & Voss, A. (2020). Product Dose Considerations for Real-world hand Sanitiser Efficacy. American Journal of Infection Control, 48(5), 503–506. https://doi.org/10.1016/j.ajic.2019.12.001.

22. Meyers, C., Kass, R., Goldenberg, D., Milici, J., Alam, S., & Robison, R. (2021). Ethanol and isopropanol inactivation of human coronavirus on hard surfaces. Journal of Hospital Infection, 107, 45–49. https://doi.org/10.1016/j.jhin.2020.09.026.

23. Dr. Abhimanyu Kuman Jha ,Mrs. Debajani Nayak ,Dr.Vinda Manjramkar; Covid-19 Impact and Response ,Vol-5 ; Oct. 2021 ; 98-99.

24. Chakraborty I.,and Malty.p.(2020),Covid-19 Outbreak: Migration , Effect On Society , Global Environment and Prevention Science of Total Environment, 728, 13882.

25. World Health Organization(WHO); Guide to Local Production: WHO Recommended Handrub Formulations; April 2010; 6-7.

26. Meneguepi M.G.,Laus A.M.,Ciol M.A.,Martis M.A.,Gir E.,Pires D.,Pittet D.;Glycerol Content Within The WHO Ethanol Based Handrub Formulation: Balancing Tolerability With Antimicrobial Efficacy; *Antimicrobial Resistance and Infection Control;* 8:109;2019; 1-2.

27. World Health Organization (WHO). WHO Guidelines on Hand Hygiene in Health Care (Advanced Draft). World Alliance for Patient Safety. Global Patient Safety Challenge 2005–2006: "Clean care is safer care" Geneva: World Health Organization, 2006.

28. Larson, E.L. APIC Guidelines For Handwashing and Hand Antisepsis In Health Care Settings. AJIC Am. J.Infect. Control 1995, 23, 251–269.

29. Denton GW. Chlorhexidine. In: Block SS, Ed. Disinfection, Sterilization and Preservation 4th ed. Philadelphia, Lea and Febiger, 1991; 274-289.

30. Ayliffe GAJ et al. A Test for "Hygienic" Hand Disinfection. Journal of Clinical Pathology, 1978, 31:923-928.

31. Aly R, Maibach HI. Comparative Study On The Antimicrobial Effect of 0.5% Chlorhexidine Gluconate and 70% Isopropyl Alcohol On The Normal Flora of Hands. Applied Environmental Microbiology, 1979, 37:610-613.

32. Rosenberg A et al. Safety and Efficacy of the Antiseptic Chlorhexidine Gluconate. Surgical Gynecology and Obstetrics, 1976, 143:789-792.

33. Rotter ML. Hygienic Hand Disinfection. Infection Control, 1984, 1:18-22.

34. Gammon, J., & Hunt, J. (2019). The neglected element of hand hygiene - significance of hand drying,efficiency of different methods and clinical implication: A review. Journal of Infection Prevention, 20(2),66–74. https://doi.org/10.1177/1757177418815549.

35. Lotfi Nejad, N., Peters, A., & Pittet, D. (2020). Hand hygiene and The Novel Coronavirus Pandemic: The Role of Healthcare Workers. Journal of Hospital Infection, 105(4), 776–777. https://doi.org/10.1016/j.jhin.2020.03.017.

36. Mashood AS, Satheesh B N, Mohd. G Formulation, Evaluation and Antibacterial Efficiency of Herbal Hand Wash Gel Int. J. Pharm. Sci. Rev. Res., 2014; 25(2): 23, 120-124.

37. Rotter M. Hand Washing and Hand Disinfection. In: Mayhall CG, ed. Hospital Epidemiology and Infection Control. 2nd ed. Philadelphia, Lippincott Williams & Wilkins; 1999:1339-1355.

38. Pereira LJ et al. An Evaluation of Five Protocols for Surgical Handwashing In Relation to Skin Condition and Microbial Counts. Journal of Hospital Infection, 1997, 36:49-65.

39. Larson EL et al. Alcohol for Surgical Scrubbing? Infection Control and Hospital Epidemiology, 1990,11:139-143.

40. Lowbury EJL et al. Preoperative Disinfection of Surgeon's Hands: Use of Alcoholic Solutions and Effects of Gloves on Skin Flora. BMJ, 1974, 4:369-372.

41. Lowbury EJL et al. Use of 4% Chlorhexidine Detergent Solutions (Hibiscrub) and Other Methods of Skin Disinfection. BMJ, 1973, 1:510-515.

42. Shulman L. Hand sanitizer: Benefits & limitations. Canadian Living: Prevention & Recovery; Nov 10, 2006.

43. Kathryne Watson, Doborah Weatherspoon; What are the Side Effects of Using Hand Sanitizer? June 17,2021.

44. Wilhelm K.-P. Current Problems in Dermatology. Volume 25. Karger Publishers; London, UK: 1996. Prevention of Surfactant-Induced Irritant Contact Dermatitis; pp. 78–85.

45. Ale I.S., Maibach H.I. Irritant Contact Dermatitis. Rev. Environ. Health. 2014;29:195–206. doi:10.1515/reveh-2014-0060.

46. Misteli H., Weber W.P., Reck S., Rosenthal R., Zwahlen M., Fueglistaler P., Bolli M.K., Oertli D., Widmer A.F., Marti W.R. Surgical Glove Perforation and the Risk of Surgical Site Infection. Arch. Surg. 2009;144:553–558. doi: 10.1001/archsurg.2009.60.

47. Larson E.L., Hughes C.A., Pyrek J.D., Sparks S.M., Cagatay E.U., Bartkus J.M. Changes in Bacterial Flora Associated with Skin Damage on Hands of Health Care Personnel. Am. J. Infect. Control. 1998;26:513–521. doi: 10.1016/S0196-6553(98)70025-2.

48. Laina Shulman; Hand Sanitizers: Benefits and Limitations; Canadian Living; Nov 10,2006.

49. Bast F, Rani P, Meena D. Chloroplast DNA Phylogeography of Holy Basil (Ocimum tenuiflorum) in the Indian subcontinent. *ScientificWorldJournal.* 2014;2014:847–482.

50. Vasudevan P, Kashyap S, Sharma S. Bioactive Botanicals from Basil (*Ocimum sp.*) *J Sci Ind Res (C)* 1999;58:332–8.

51. Chandrappa P. M.,Dupper A., Konthoujam S.;Antimicrobial Activity of Herbal Medicines (tulsi extract, neem extract) and Chlorhexidine Against Enterococcus Faecalis in Endodontics: An in Vitro Study; Journal of International Society of Preventive and Community Dentistry; Vol 5; Dec 2015; S89-S90.

52. Vinothkumar TS, Rubin MI, Balaji L, Kandaswamy D. In Vitro Evaluation of Five Different Herbal Extracts as an Anti-microbial Endodontic Irrigant Using Real Time Quantitative Polymerase Chain Reaction. J Conserv Dent. 2013;16:167–70.

53. Alghamdi HA. A need to Combat COVID-19; Herbal Disinfection Techniques, Formulations and Preparations of Human Health Friendly Hand Sanitizers. Saudi Journal of Biological Sciences. 2021 Apr 9. https://doi.org/10.1016/j.sjbs.2021.03.077

54. C. A. C. Araújo e L. L. Leon, Biological activities of Curcuma longa L, Memórias do Instituto Oswaldo Cruz, vol. 96, no. 5, pp. 723–728, 2001.

55. F. Habeeb, E. Shakir, F. Bradbury et al., "Screening Methods Used to Determine the Anti-microbial Properties of Aloe Vera Inner Gel," Methods, vol. 42, no. 4, pp. 315–320, 2007.

56. J. P. Heggers, G. R. Pineless, and M. C. Robson, "Dermaide aloe/Aloe vera gel: Comparison of the Antimicrobial Effects," Journal of the American Medical Technologists, vol. 41, no. 5, pp. 293–294, 1979.

57. A. O. Azghani, I. Williams, D. B. Holiday, and A. R. Johnson, "A Beta-linked Mannan Inhibits Adherence of Pseudomonas Aeruginosa to Human lungs Epithelial Cells," Glycobiology, vol. 5, no. 1, pp. 39–44, 1995.

58. Maruti J. Dhanavade, Chidamber B. Jalkute, Jai S. Ghosh and Kailash D. Sonawane. Study Antimicrobial Activity of Lemon (Citrus lemon L.) Peel Extract. Br. J. Pharmacol. Toxicol. 2011; 2(3): 119-122.

59. "Clean Hands Save Lives!" (https://www.cdc.gov/handwashing/when-how-handwashing.html) .Centers for Disease Control and Prevention. 11 December 2013. Archived(https://web.archive.org/web/20170818165220/https://www.cdc.gov/handwashing/when-how-handwashing.html) from the original on 18 August 2017.

60. Boyce JM, Pittet D, Healthcare Infection Control Practices Advisory Committee,

HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force (October 2002).

61. Treewear Ecological Living: https://www.treewear.org/blogs/the-treewear-initiative/advantages-of-alcohol-free-hand-sanitizer.

62. Advantages of Herbal Hand Sanitizers are Available on https://infinitabiotech.com/blog/benefits-of-hand-sanitizer/.

63. Subbiya A, Mahalakshmi K, Pushpangadan S, Padmavathy K, Vivekanandan P, Sukumaran VG. Antibacterial efficacy of Mangifera indica L. kernel and Ocimum sanctum L. leaves against Enterococcus faecalis dentinal biofilm. J Conserv Dent. 2013;16:454–7.

64. Geeta, Vasudevan DM, Kedlaya R, Deepa S, Ballal M. Activity of ocimum sanctum (the traditional Indian medicinal plant) against enteric pathogens. Indian J Med Sci. 2001;55:434–8. 472.

65. Agarwal P, Nagesh L, Muralikrishnan Evaluation of the antimicrobial activity of various concentrations of Tulsi (Ocimum sanctum) extract against Streptococcus mutans: An in vitro study. Indian J Dent Res. 2010;21:357–9.

66. Blog on Alcohol- Based Sanitizer Vs Alcohol- Free Sanitizer: https://www.cupidlimited.com/blog/alcohol-based-vs-alcohol-free-hand-sanitizer/.