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"EVALUATION OF THE EFFICACY OF HAND SANITIZERS"
-Use Simple Science to Test Your Corona Warrior – The HandSanitizer.

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ABSTRACT
Microorganisms living on the surface of the skin and in the surroundingscancausemanyinfectiousdiseasesin the humanbody.Antisepticisachemicalsubstancethatfunctions as a killerorobstructionofmicroorganism growth on the skin surface. This is important to preventinfectiousdiseases(Levinson,2008).

One of the simple ways to be antiseptic is hand washing (Rachmawati &Triyana, 2008). Hand sanitizer is an alternative product used to washhandsbesidestheusageofsoapandwater(Liuetal., 2010).Handsanitizer,which generally has alcohol and phenol substance, has the mechanism ofdenaturizing and coagulating bacterium cell protein, to make the lyses ofthemembranecellandchangingthepermeabilityofthecellmembraneofthe bacteria so that it can cause leakage in the essential cell constituentandkilltheVirus.
Keywords: Microorganisms, hand washing,infectious diseases

OBJECTIVE
The stated objective of this project is to evaluate and compare the efficiency of various-the-shelfhelf sanitizers available on the market using simple chemical tests that can be performed at home.

Covid19

- Coronavirus disease 2019 (COVID-19) is an infectious disease caused bysevere acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It was firstidentified in December 2019 in Wuhan, Hubei, China, and has resulted inanongoingpandemic.Asof14September2020, morethan29millioncaseshave been reported across 188 countries and territories with more than924,000deaths;more than19.6millionpeoplehave recovered.
- Common symptoms include fever, cough, fatigue, shortness of breath orbreathing difficulties, and loss of smell and taste. While most people havemild symptoms, some people develop acute respiratory distress syndrome(ARDS),multi-organfailure,septic shock,and bloodclots.
- The virus is spread primarily via small droplets from coughing, sneezing,and talking. The droplets are usually not airborne; however, those standingnearby may inhale them and become infected. People may alsobecomeinfectedbytouchingacontaminatedsurfaceandthentouchingtheirface. It is most contagious during the first three days after the onset ofsymptoms, although the spread is possible before symptoms appear, and fromasymptomatic people.
- The standardmethod of diagnosisis by real-time reverse transcription-polymerase chainreaction(RRT-PCR)froma nasopharyngealswab.
- Recommendedmeasurestopreventinfectionincludefrequenthandwashing,socialdistancing,quarantine,coveringcoughs,andkeepingunwashed hands away from the face. The use of cloth face coverings suchas a mask has been recommended by health officials in public settings tominimize the risk of transmissions, with some authorities mandating theiruse.
- Therearenoprovenvaccinesorspecifictreatments forCOVID-19.Management involves the treatment of symptoms, supportive care, isolation,andexperimentalmeasures.TheWorld HealthOrganization(WHO)declaredtheCOVID-19outbreakapublichealthemergencyofinternationalconcern on 30 January 2020 and a pandemic on 11 March 2020. Localtransmission of the disease has occurred in most countries across all sixWHOregions.

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KeepingYourselfSafe

Thebestwaytopreventthespreadofinfection sanddecreasetheriskof gettingsickis by washing your hands with plain soap and water, as advised by the Center forDisease Control and Prevention (CDC). Washing hands often with soap and waterfor at least 20 seconds is essential, especially after going to the bathroom; beforeeating; and after coughing,sneezing,orblowingone'snose.

If soap and water are not available, CDC recommends consumers use an alcohol-basedhandsanitizerthatcontainsatleast60%alcohol(alsoreferredtoasethanolorethylalcohol).

Theviraltargetsof alcohol-basedhandsanitizersarepredominantlytheviralenvelope, if present, which is derived from host lipid envelopes, the protein capsid,which contains and protects the genetic material, and the genetic material itself.Giventhatallthesecomponentsarenecessaryforthevirallifecycle(e.g.attachment, penetration, biosynthesis, maturation, and lysis), and thus critical for itsability to transmit to another host, altering the structure or function of any of theabove-mentionedcomponentswilltypicallyrenderthevirus ineffective.

Today, we have a range of options for hand hygiene. Bar soaps, liquid soaps,antimicrobial soaps, and of course titular hand sanitizers. As coronavirus spreads,the keyadvicehasbeentomakesure youregularlywashyourhands.

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Hand sanitizer becomes a warrior when soap and water are not available or whenoneisonthemoveandespeciallyinsettingswhere compliancewithhandwashingispoor. For example, among children in elementary schools, theincorporation of eitheran alcohol-based or an alcohol-free hand sanitizer into classroom hand-hygieneprograms has been associated with reductions in absenteeism related to infectiousillness.Likewise,intheworkplace,theuseof alcohol-basedhandsanitizerhasbeenassociated with reductions in illness episodes and sick days. In hospitals and healthcare clinics, increased access to alcohol-based hand sanitizer has been linked tooverallimprovementsinhandhygiene.

What'sinthese sanitizers?

Handsanitizerisaliquid,gel,orfoamgenerallyusedto decreaseinfectiousagentsonthehands.

TherearevarioustypesofSanitizersavailable onthe market

1. Alcohol-based(Isopropyl/Ethanol)
2. Ammoniabased(Benzethonium/BenzalkoniumChloride)
3. Silver/Iodinebased
4. Chlorine-based(Chlorhexidine/Cetrimonium)
5. Triclosanbased
6. EssentialOil-based(Cinnamon,Clove,Thymol)

Alcohol-based hand sanitizer works against a wide variety of micro-organisms butnot spores. The alcohol-based version is on the World Health Organization's List ofEssential Medicines, the safest and most effective medicines needed in a healthsystem.

Thealcohol-basedsanitizersusuallycontainethanol.Otheralcohols usedareisopropanol (commonly known as rubbing alcohol), and, less commonly, propanol.Alcohol-basedversionstypicallycontainsomecombinationofisopropyl alcohol, ethanol (ethyl alcohol), or n-propanol, with versions containing 60% to95%alcoholthemosteffective.

Manufacturers add other ingredients for various reasons. These include additionalagentswhichareactiveagainstvirusesorbacteria,suchaschlorhexidineorbenzalkoniumchloride.Theseingredientsarealsokeyinnon-alcohol-basedsanitizers. Ingredients such as glycerol stop your hands from drying out. Hydrogenperoxide,addedinsmallamounts,preventsbacterialcontaminationofthesanitizer.

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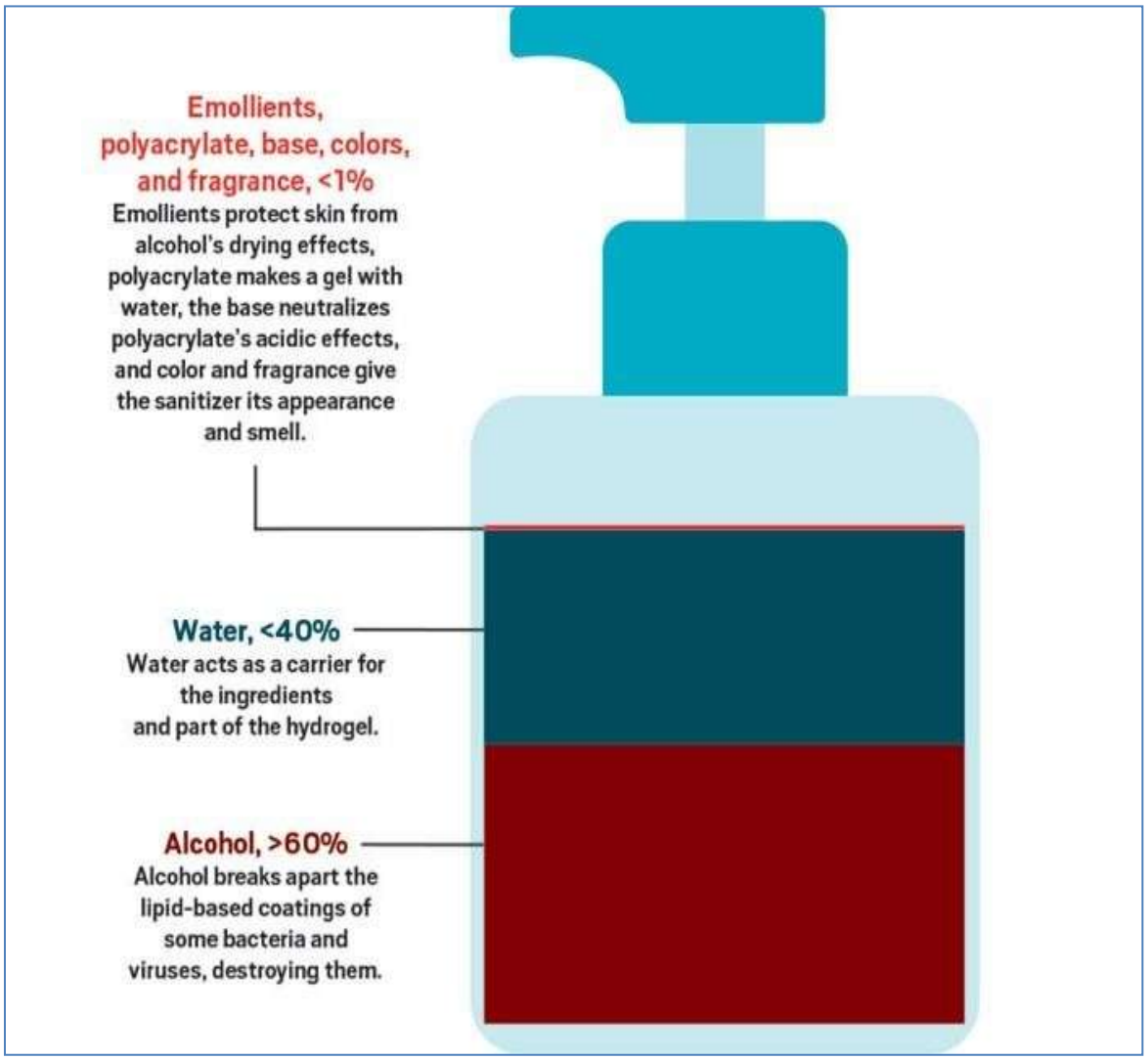

Alcohols are effective at killing most bacteria and viruses. They affect the structureof proteins, causing them to become misshapen or 'denatured'. Through this theydestroytheoutershellsofvirusesandbacteria,killingthemandpreventinginfections.

Though they're effective in most cases, there are some types of viruses they can'tdestroy.Thesearevirusesthat don'thavetheouterlayer(knownasanenvelope).**Coronavirus is an enveloped virus, so alcohols are effective against it.** Non-envelopedviruses,suchasnorovirus,aren'tkilledbyalcohol.

Chlorhexidinesometimesaddedtoalcohol-containingsanitizers,iseffectiveagainst bacteria and viruses. There's some evidence that its addition to alcohol-basedsanitizersincreasesits effectiveness.

Benzalkonium Chloride is often used in non-alcohol-based hand sanitizers. It hassome effectiveness against bacteria and limited activity against viruses. It's also slowto act, meaning that non-alcohol-based sanitizers are generally less effective thanalcohol-basedones. TheCDCstatesthattheavailableevidenceisthatBenzalkoniumChlorideis notas effectiveagainstcoronavirus asalcohols.

Howdoalcohol-basedhandsanitizerswork?

WhatisIsopropylalcohol?

Isopropyl alcohol (2-propanol), also known as isopropanol or IPA, is the mostcommon and widely

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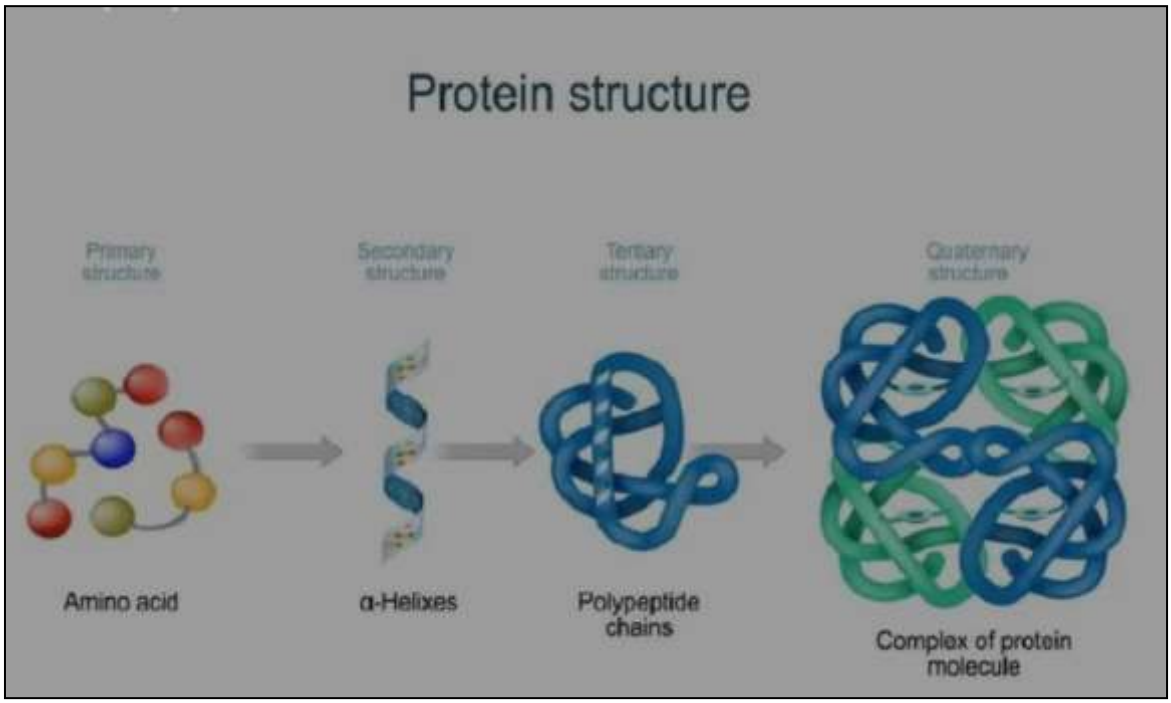
used disinfectant within pharmaceutics, hospitals, clean rooms,andelectronicsormedicaldevicemanufacturing.Differentsolutions,puritygrades,concentrations,andalcoholtypesyieldbeneficialcleaninganddisinfectionpropertieswhenappliedcorrectly;or dangerous consequenceswhenusedimproperly.

Isopropylalcohol,particularlyinsolutionsbetween60%and90%alcoholwith10–40% purified water, is rapidly antimicrobial against bacteria, fungi, and viruses.Once alcohol concentrations drop below 50%, usefulness for disinfection dropssharply.

Notably, higher concentrations of alcohol don't generate more desirable bactericidal,virucidal,orfungicidalproperties.

The presence of water is a crucial factor in destroying or inhibiting the growth ofpathogenic microorganisms with isopropyl alcohol. Water acts as a catalyst andplays a key role in denaturing the proteins of vegetative cell membranes. 70% IPAsolutions penetrate the cell wall more completely which permeates the entire cell,coagulatesallproteins,and thereforethemicroorganismdies.



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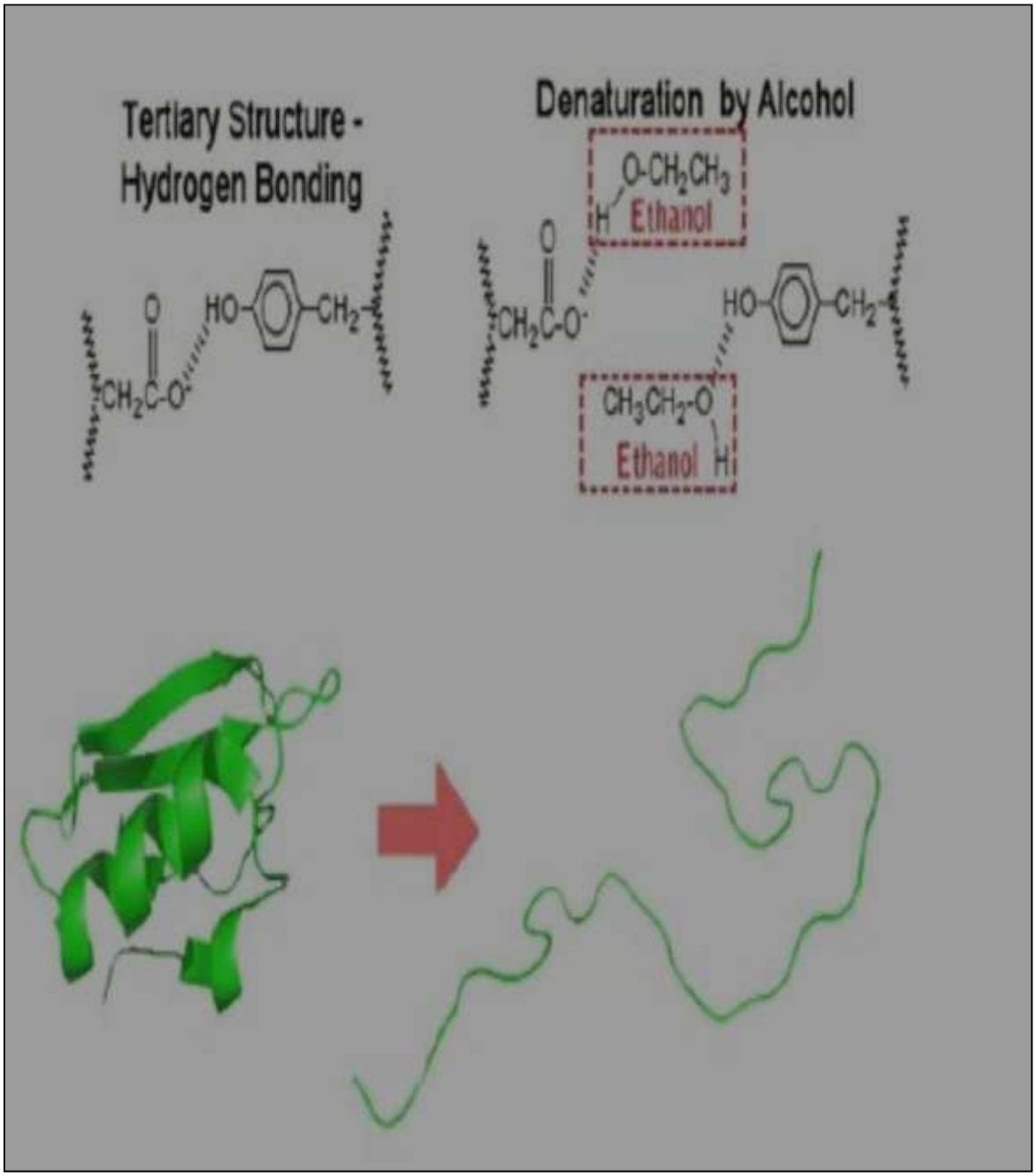

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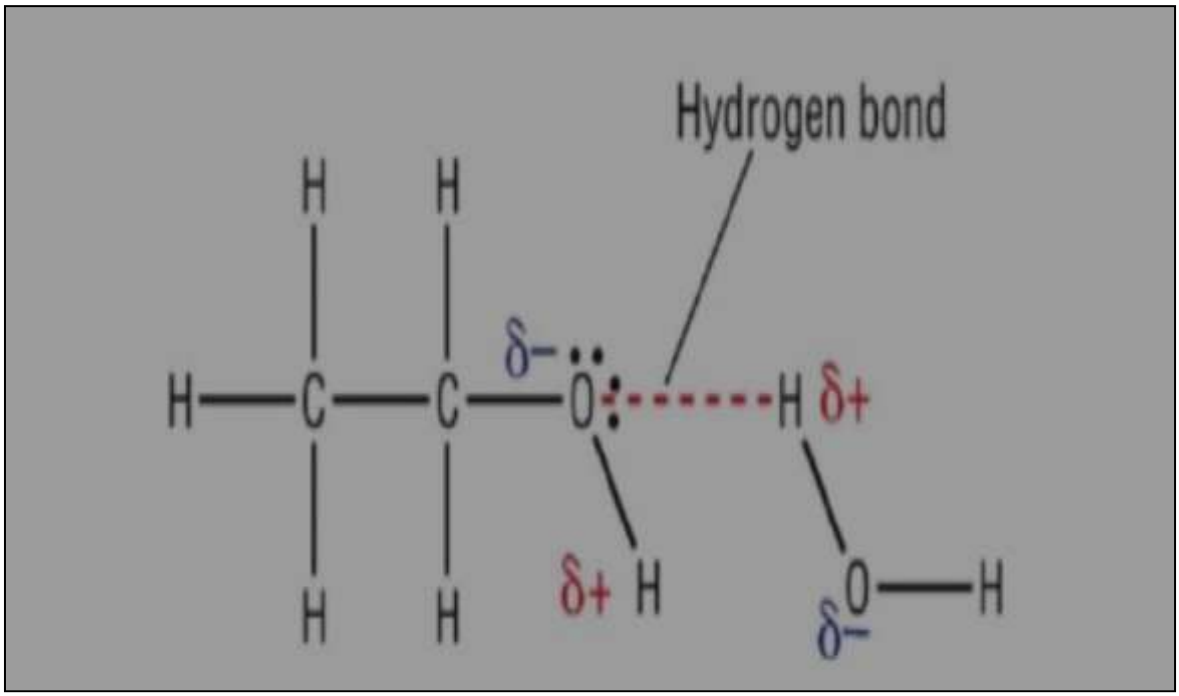

- Extra water content slows evaporation, therefore increasing surface contacttimeandenhancingeffectiveness.Isopropylalcoholconcentrationsover91%coagulateproteinsinstantly.Consequently,aprotectivelayeriscreatedwhichprotectsotherproteinsfromfurthercoagulation.
- Solutions having more than 91% IPA does kill bacteria, but sometimes requireslonger contact times for disinfection, and enables spores to lie in a dormantstatewithoutbeingkilled.

IsIsopropylAlcoholtheSameasRubbingAlcohol?

Rubbingalcoholisanantiseptic,whichcontainsnot lessthan68%andnotmorethan72%ofisopropylalcohol.The remaining volumeconsists ofwater.

HoweffectiveisaSanitizercomparedtowashinghands?

There are a few criteria that hand sanitizers need to meet to be most effective.Alcohol-basedsanitizersaremoreeffectivethantheirnon-alcohol-basedcounterparts. However, the alcohol percentage by volume needs to be at least 60%.Belowthis,they'relesslikelytokillthebacteria andviruses onyourhands.

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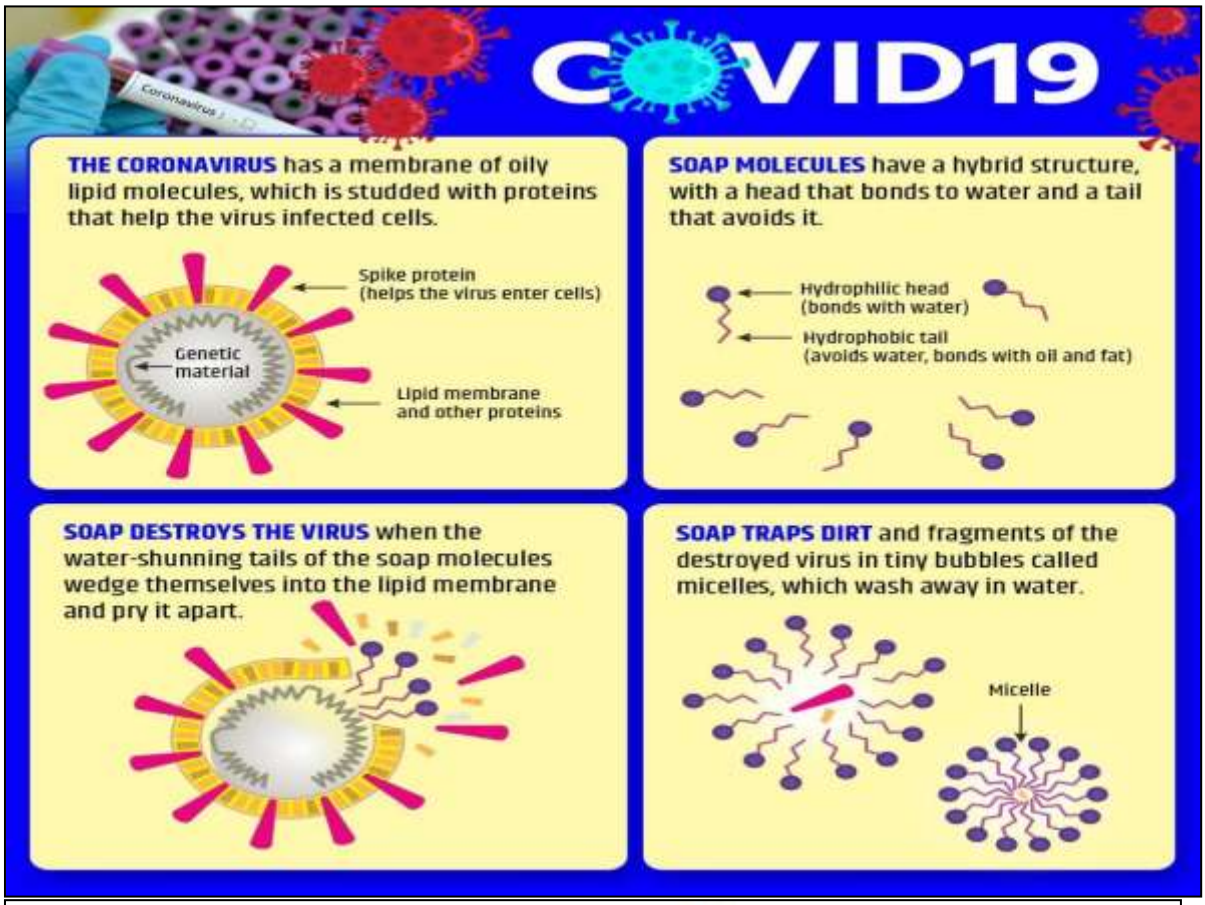

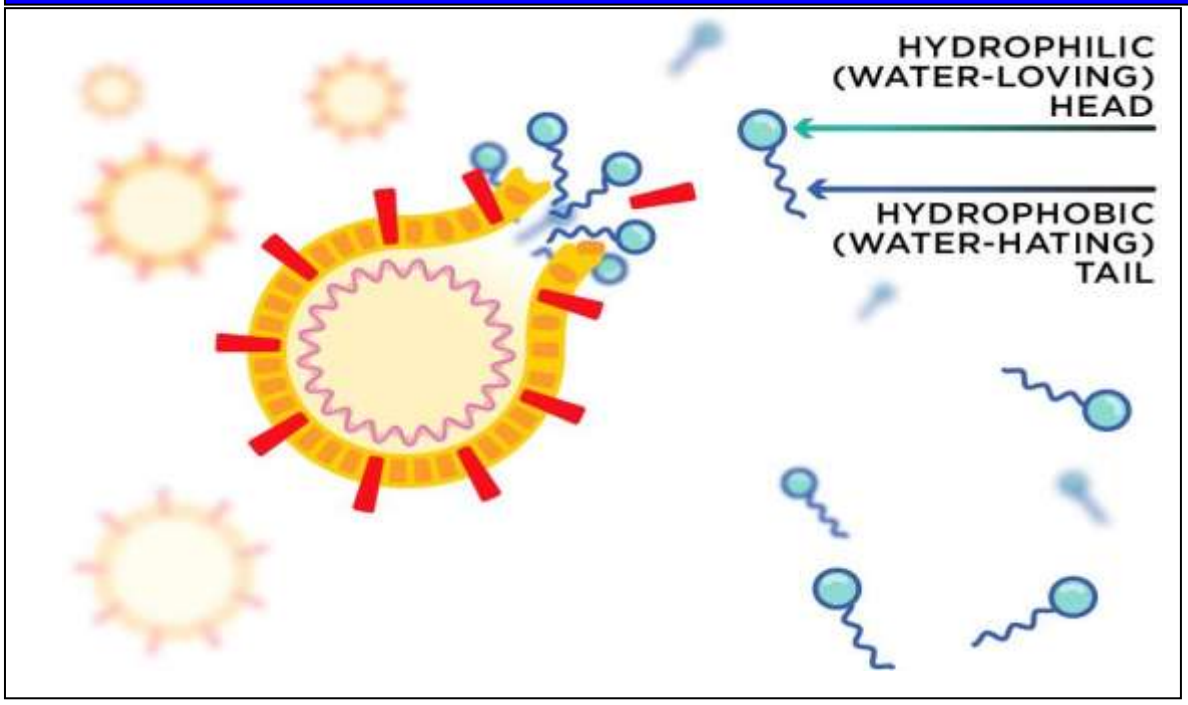

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- The potency of alcohol-based hand sanitizers increases with the percentagebyvolumeofalcohol.Sohigherpercentagesarelikelytobebetter.However,very high concentrations (above 95%) are less effective. This is becauseproteinsaren't denatured aseasilywhenthereisn't wateraround.

- Anotherkeyfactoristhevolumeofhandsanitizerused.Itneedstobeenoughto cover all areas of both hands — otherwise, you're leaving areas whereviruses and bacteria could continue to linger. To properly coat your hands,youneedtouseabout3milliliters ofsanitizer(approximatelyapalm full).

- Finally, the dirtiness of your hands is also a factor. If they're covered in dirtor grease, hand sanitizer won't be effective in removing this. Bacteria orvirusesinthedirton yourhandscould remainasa result.

- With these caveats, it's easy to see why recommendations have focused onhand-washing.Ifyouwashyourhandsforthe20 seconds recommended,it'llremove dirt,grease,viruses, andbacteria.

AllHandSanitizersAreNotEqual

- Handsanitizerisamongtheseveralpersonalcareproductsthathaveshiftedfrombeing luxury products to essential items due to the changing socio-economicscenarioandincreasingwesternization andurbanizationtrendsinIndia.Furthermore, the demand for hand sanitizers has surged since 2020 as a result ofthe Covid-19 outbreak. This has resulted in several players - small and large-enteringthismarket.

- Looking at the massive demand, several small players have also resorted tomanufacturinghandsanitizersusinglow-quality/cheapingredientslikemethanol, benzene, and toluene among others which can damage the skin anddomoreharmthanrelief.

- Severalonlineblogsandvideopoststeachhowtomakesanitizersathomewithaloe vera and camphor, etc. Nobody knows how effective these homemade handsanitizers are and health authorities are urging people to use only alcohol-basedhand sanitizersboughtfromapharmacyorahospital.

Therecommended testing methodfor determining thequantity of alcohol in sanitizeris gas chromatography. All manufacturers of Sanitizers are required to test everybatchof theirproductforalcoholcontentbyusingthistechnique. Unfortunately, this requires a piece of sophisticated equipment that costs tens ofthousandsofdollars andmostofthemanufacturers don'thavethisequipment.

Quality-conscious and good manufacturers who do not have gas chromatographyequipment work with contract testing labs where they send their products for testingto ensurethequalityof theproduct.

Still, the testing of sanitizer is expensive and out of the reach of consumers andretailers who might be using just using a few bottles and the cost of testing will bemore than the cost of the product. Just getting one sample tested can cost up to 300Rupees(40USD).

TESTITBEFOREYOUUSEIT

Three(3)simpleexperiments,whichcanbedoneathome,willbeconductedtocomparethechosensanitizers.Thesetestsare:

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1. TheTissuepapertest
2. Thewheatflourdoughtest
3. Thehairdryertest

TestObjective-Investigationtofindtheefficiencyofthesanitizerbycomparingtheamountofalcoholpresentinthem.

SelectionoftheSanitizersamples:

1. Randomselectionof4sanitizers fromthelocalsupermarket
2. Allthesesanitizerlabelsclaimtohavetherequiredpercentageofalcoholtokill theCoronavirus
3. Rubbingalcoholwillbeusedforthecontrolexperiment

Tests -4samplesofsanitizersfrom differentcompaniesandsomeRubbing Alcohol(ISOPROPYL)were taken.

- Sample1–NaturalAromaSanitizer(Water-Based)
- Sample2–MedikerAdvancedHandSanitizer (GelBased)
- Sample3–SavlonHexaProSanitizer(Water-Based)
- Sample4–Bath&BodyWorks“Spread&Sparkle”Glittered&ScentedHand Sanitizer(GelBased)

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TheTissuePaperTest

MaterialsRequired

1. Tissuepaperroll
2. Ballpoint pen(un-washable)
3. Somethingtodrawasmallcircle,suchasacoin or capofthesanitizer bottle.
4. Sanitizers
5. Water
6. Rubbingalcohol

Principle

Thissimpletestisbasedontheprincipleofpaperchromatography.Theinkwhichisusedinwater-resistantballpointpens doesnotdissolveinwaterbutveryquicklydissolvesinalcohol.Thiscausesthe ink to move along the front of the diffusing sanitizer and spread out. If the alcohol contentisless,the solubilityoftheinkisnot sufficientand theline doesn't move.

Procedure

1. Take a small piece of tissue paper and keep it on a flat surface. You mustn'tmakeathickwadofthetissuepaperasyouwantthesanitizerto defusesidewaysonlyandnotdownintothetissuepaper.
2. Use a ballpoint pen and carefully draw a circle on the paper by outlining a coin or the capofthehandsanitizerbottle.Make surethelineiscontinuous,thick, and clear.
3. Place a few drops of the hand sanitizer in the middle of the circle. Be careful not to pourtoomuchsanitizerthatitoverrunstheline,norshoulditbetoolittlethatitdoesn't diffusepasttheline.
4. Let the hand sanitizer slowly diffuse and move out of the circle. The liquid sanitizer willdiffuse almostinstantlywhilethe gel-basedwilltakesome time.
5. Repeatthiswithalittlebitofwatertoseehowafakesanitizer withoutalcoholbehaves.

Hypothesis

Sanitizerscontainalcoholandhencewilldissolvethepeninkandcolorwillstarttospreadout

TestResults

Sampleno.	**SAMPLENAME**	**AMOUNT OFSANITIZERTAKEN (IN ML)**	**OBSERVATION**	**INFERENCE**
1	NATURALAROMA	1ML	The ink got partiallydissolved andspreadoutintoa smalldistance from thecircumference ofthe circledrawn.	The sanitizerhasLessalcoholcontent

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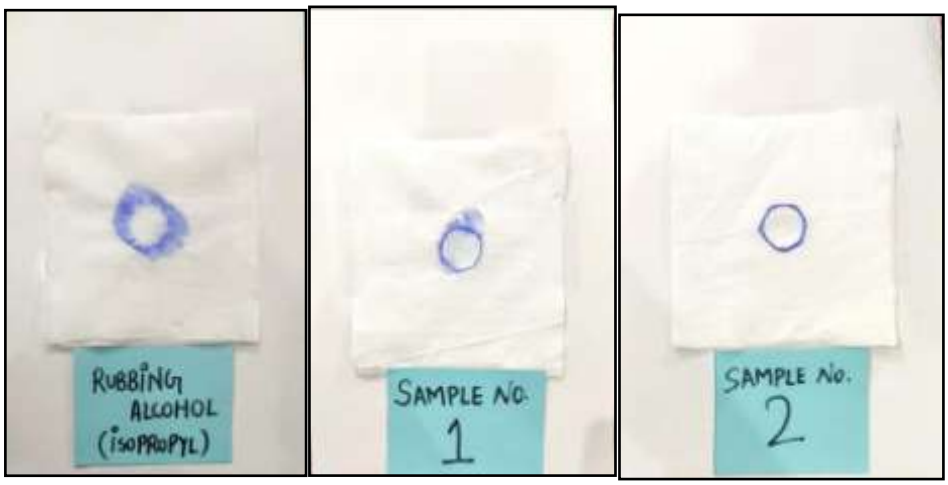
2	MEDIKER	1ML	Theinkdidn'tgetdissolved and thespreadingoutoftheink canbecallednegligible.	The sanitizerhasLessalcoholcontent
3	SAVLON	1/2ML	Theinkgot dissolved andspreadoutinall directionsrapidly.	The sanitizerhasHighalcohol content
4	BATHANDBODY WORKS	1ML	Theinkdidn'tdissolveverywellandspreadoutintoasmall distance fromone sideofthe circumference.	The sanitizerhaslessalcoholcontent

Resultwithwaterandrubbingalcohol

When we used 1 ml of rubbing alcohol, isopropyl dissolved the ink and spread out the ink color.However, when 1 ml of water was poured, the water spread without diffusing the ink pen linecolor.



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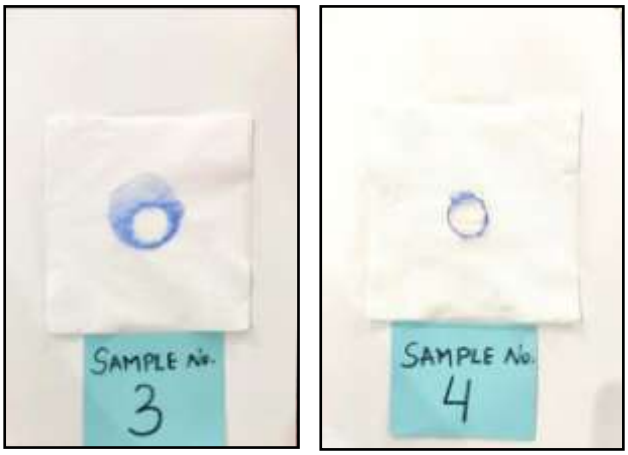

Summaryofobservations

1. All4sanitizershave alcoholpresentinthem
2. Sampleno. 3 indicatedtohavethehighestcontentofalcoholasper thisexperimentduetomaximumandmostrapiddiffusion
3. Sampleno. 1showslessalcoholcontentascomparedtoSavlon.
4. In Sample nos. 2 and 4 not much diffusion was noticed which indicates less content ofalcohol.

Limitation

Thegel-basedsanitizersdon'tgetabsorbedeasilyortaketimeto getsoakedinthetissuepaperandhencecanmarginallyaffecttheresults.

TheWheatFlourDoughTest

MaterialsRequired

1. Halfcupofwheat flour
2. 6bowlsandplates
3. Measuringcup
4. Water
5. Rubbingalcohol
6. Sanitizers

Principle

Thistestisbasedonthesimplefactthatflourneedswaterfortheglutenandcarbohydratestoswelland become sticky and turn into dough. Alcohol, on the other hand, competes with the gluten andcarbohydrates for the water molecules and won't let them hydrate and become sticky. This test isverysensitive andcaneasilydetectsamples with60percentorlessalcohol.

Procedure

1. Takeone teaspoonofwheatflourona plate.
2. Add a quarterteaspoonofthesanitizeryouwanttotest.Donotaddtoomuchofthesanitizer.
3. Kneadtheflourandthesanitizertogethertomakeadough.

Hypothesis

Thesanitizerswillnotforma doughwhenkneadedwiththewheatflour,henceindicating thepresenceof the requiredamountofalcohol.

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TestResults

SAMPLE NO.	SAMPLENAME	OBSERVATION	INFERENCE
1	NATURALAROMA	Mostofthewheatflourformed doughafterthe sanitizerwasmixed.	The alcoholcontentislessthan60%
2	MEDIKER	Alargerpartofthewheatflour formed doughafter thesanitizerwasmixed.	The alcoholcontentislessthan60%
3	SAVLON	Verylooseclumpswere formed,thatquicklyfellapart.	The alcoholcontent isover60%
4	BATH AND BODYWORKS	1/3rdofthewheatflour formedsmallclumps.	The alcoholcontentisover 60%

ResultwithWaterandRubbingAlcohol
When we kneaded One (1) teaspoon of wheat flour with a quarter teaspoon of water the flourquicklybecamestickyandeventuallyturnintoa dough.

When we kneaded (One) teaspoon of flour with a quarter teas spoon of rubbing alcohol, the flourdid not become sticky and remained as a powder and eventually the rubbing alcohol dried upleavingthepowderflour.

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Summaryofobservations

1. Sampleno.3isfoundtohave a maximumamountofalcoholcontent.Whenmixedwith wheatflourveryloose clumps wereformedthatquicklyfellapart.
2. Samplesno.1and2 havelessthan60% alcoholcontent.

MaterialsRequired

TheHairDryerTest

1. Hair-dryerwithelectricconnection
2. 6bowls
3. Measuringcup
4. Stopwatch
5. Sanitizers
6. Rubbingalcohol
7. Water

Principle

This test is based on the principle that alcohol has a much lower boiling (78 - 82-degree C) pointcompared to water (100-degree C). When the sanitizer is subjected to hot air from a hairdryer,some volume of the alcohol present in the sanitizer evaporates. Water on the other hand due toits higher boiling point does not evaporate so quickly. The more the sanitizer evaporates indicateshigherthe contentofalcoholinthe sanitizer

Procedure

1. Takeonetablespoon(15ML)ofthesanitizerin asmallbowl.
2. Usingahairdryer,drythesanitizerfor30secon ds.Makesuretoletthehairdryerheatupbeforeyoustart.
3. Inthesamewayandatthesametemperaturefro mthesamedistanceasthecontrolexperimentwithwater inabowl

Hypotheses

All Sanitizershaveacertain amountof alcoholandwill dry upsignificantlycomparedtoevaporationwaterintheco ntrolexperiment.

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TestResults

SOLUTION	AMOUNT OFSANITIZERTAKEN(IN ML)	THE AMOUNT OFSANITIZERLEFTOUT (IN ML)	OBSERVATION
WATER(H_2O)	15ML	14ML	**1ML**ofthe sanitizerdriedup
RUBBING ALCOHOL(ISOPROPYL)	15ML	10ML	**5ML** of thesanitizerdriedup

ResultwithWaterandRubbingAlcohol

When 15 ml of water was put under the hairdryer for 30 seconds, 1 ml ofevaporationwasrecorded.However,in the caseofrubbingalcohol,5mloftheliquidevaporatedin30seconds.

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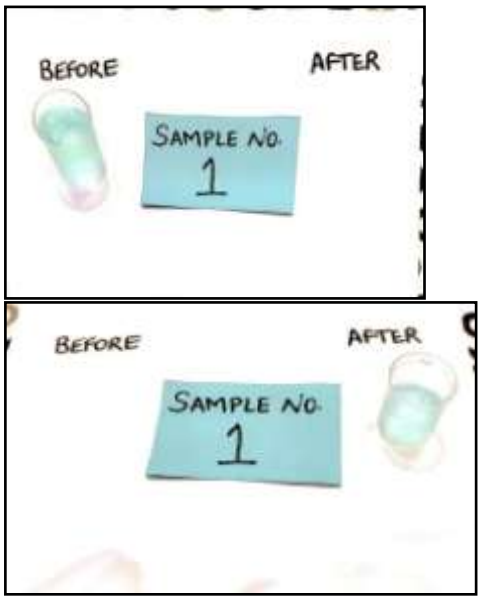
Sampleno.	SAMPLENO.	AMOUNTOFSANITIZERTAKEN(IN ML)	AMOUNTOFSANITIZERREMAINING (IN ML)	OBSERVATION	INFERENCE
1	NATURALAROMA	15ML	12ML	3ML of thesanitizerdried up	A fair amountofalcohol
2	MEDIKER	15ML	14ML	1MLofthe sanitizer driedup	Low alcoholcontent
3	SAVLON	15ML	11ML	4ML of thesanitizerdried up	Highalcohol content
4	BATH& BODYWORKS	15ML	13ML	2MLofthe sanitizer driedup	Slightlyless alcoholcontent

SummaryofObservations

1. The hypothesisisproventoberight,asthesanitizerswithmorealcoholcontentdryupfasterwhensubjectedtothehair-dryer

2. The alcoholcontent ofthe tested samples isasperthe tableabove.



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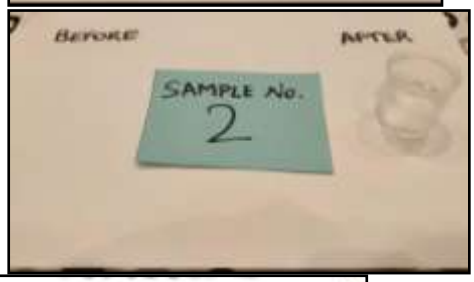

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CONCLUSION

Handsanitizersworkby dissolvingthecell membraneof thevirusorbacterium andthendenaturingtheproteinsthatareessentialtotheir life.Sanitizersarea typeofantimicrobialthatkillsorirreversiblyinactivates atleast99.9%ofallbacteria, fungi, andviruses(calledmicrobial, micro-biological, ormicro-organism)presentona surface.

Theeffectivenessofhandsanitizerdependso nmultiplefactors,includinghowtheproductisapplied. e.g.,quantityused,durationofexposureandfrequency ofuse, etc.)andwhetherthe specificinfectiousagents presentonthe person'shandsare susceptible tothe activeingredientintheproduct.Ingeneral,alcohol-basedhandsanitizers,ifrubbedthoroughlyoverfingers andhandsurfacesfor30seconds,followedby completeair-drying,caneffectivelyreduce populationsofbacteria,fungi, andsome envelopedviruses

AccordingtoWHO(WorldHealthOrganizati on), Handsanitizerworksgreatandisveryeffectiveat killing bacteria, fungi, and viruses. According to CDC (Centre for Disease Control) Practicinghand hygiene is a simple yet effective way to prevent infections continue to use healthcareantiseptic products currentlyrecommended.

There are many types of sanitizers available in the market. Many manufacturers have startedsellingsanitizerswithfakelabelsandcontentsto make a profit.Thescaredgeneralpopulationbuyswhichever sanitizer is available in the vicinity of their homes and starts using it thinking it willprotect them.The tests used in this project can be performed at home at a very low cost todifferentiate effective sanitizersfromineffectiveones.

In this project the sanitizer made by the brand Savlon was found to be most effective followed byNature Aroma, Mediker and last was Bath and Bodyworks. This primarily could also be becauseoftheadditionsthatthemanufacturersmadeint hesanitizerstomakethemattractiveandsaleable(additi onofglitterandscents).Theseproductsmightlookands mellgreat butwillnotprotectonefromthedangerousviruses andbacteria readytoinvade us.

Followingconclusionscan bedrawn,basedon theanalysisoftheobservationsof thethreetestsconducted onthesanitizers

1. Sampleno.3hasan alcoholcontent of over 60% andcangivetherequiredprotectionagainstCoronavirus
2. Sampleno.1haslessalcoholcontentthanSampleno.3.
3. Sampleno. 2andSampleno. 4havemuchlessthan60%alcoholcontentandhenceare notfittoprotectagainstCoronavirus
4. Notallhandsanitizersavailableonthemarkethavetherequiredalcoholcontenttopr otectfromCoronavirus

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PRECAUTIONS

1. *Becarefulwhilehandlingalcohol-basedsanitizers, especiallyduring tests involvingdryingwithahairdryer.*
2. *Beverycarefulwhilepouring sanitizer fortheinkdissolvetest. Puttingtoomuchortoolittlesanitizerwillaffectthetestresults*
3. *Preferably wearamaskandhandgloveswhile conductingthetests.*

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