Monitoring Quality of Alcohol-Based Hand Sanitizers Used in Johannesburg Area During the Covid-19 Pandemic.

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Abstract

Since the outbreak of the Coronavirus Disease 2019 (CoViD-19), the World Health Organization has recommended that, in the absence of soap and water, alcohol-based hand sanitizer can be used to prevent the transmission of coronaviruses. Unfortunately, many media reports indicate that majority of current alcohol-based hand sanitizers are substandard and some contain potentially toxic ingredients.

The study aimed to identify sanitizers used in the Johannesburg area that do not contain the WHO-recommended alcohol concentration of at least 70% propanol or 60% ethanol, and contain traces of toxic ingredients. Hand sanitizers were randomly collected from various traders around Johannesburg. The samples were analyzed using Agilent Auto sampler coupled to a gas chromatograph utilizing flame ionisation detection.

Of the 94 different hand sanitizers collected, three preparations were found to contain no alcohol, whereas the rest contained either ethanol or 2-propanol or a combination of the two. Of the alcohol-containing sanitizers, 37 (41%) contained less than 60% v/v alcohol. Ethyl acetate, isobutanol and other non-recommended alcohols (methanol, 1-propanol and 3-methyl-butanol) were also identified. Consumers are therefore warned that among the many brands of hand sanitizer found around Johannesburg, there are some substandard preparations and some that contain traces of toxic ingredients.

1. Background

The gold standard for hand hygiene and preventing the spread of infectious diseases is regarded as washing with warm water and soap, because water and soap remove oils from hands that can harbour pathogens [1]. However, in the absence of water, hand sanitizers (also called hand antiseptic or hand rub) are recommended [2, 3].

Since the outbreak of SARS-CoV-2, CoViD-19 (coronavirus), it is recommended by the World Health Organisation (WHO) that, in absence of water, the use of alcohol-based hand sanitizers can prevent the transmission of coronavirus [4]. Consequently, the demand for hand sanitizers has increased worldwide including South Africa, resulting in a surge in the trade of hand sanitizers and initially leading to shortages in their supply.

Sanitizer formulations exist in the form of liquids, gels and foams. Depending on the active ingredient used, hand sanitizers can be classified as one of two types: alcohol-based and alcohol-free. Alcohol-based sanitizers are recommended for general use, whereas the alcohol-free ones are not [5, 6]. Hand sanitizers without alcohol or with less than the recommended alcohol content (60–95% alcohol) have been found not to work well for many types of pathogens, in that they may merely reduce their growth rate and hence reduce their numbers rather than kill them outright [7].

Alcohol-based hand sanitizers are available in the form of rinses (liquid) and rubs (gel, foam and cream), and both are effective agents for reducing the number of viable pathogens, including coronavirus, on hands. Alcohol-based hand sanitizers may contain a variety of alcohols [e.g., methanol, isopropyl alcohol (isopropanol, 2-propanol), ethanol (ethyl alcohol), n-propanol] or a combination of these [8], including other ingredients (see Table 1).

Table 1
Ingredients commonly found in hand sanitizers [8, 9, 10, 11].

Ingredient	Examples/Notes
Alcohol	Examples: ethanol, 2-propanol, n-propanol. Sixty to 95%v/v alcohol strength is the most effective. Usually a combination composed of ethanol (ethyl alcohol) and 2-propanol (isopropyl alcohol, 2-propanol) is preferred. Ethanol (70%v/v) is a generally broad-spectrum germicide and therefore considered superior to 2-propanol.
Sporicide	Example: hydrogen peroxide. Hydrogen peroxide eliminates bacterial spores within the bottle of hand sanitizer and does not play a role as a sanitizer.
Emollients	These are skin moisturisers and gelling agents, e.g. glycerol, aloe vera gel. They help to protect skin from the drying effects (e.g., scaling or fissures developing in the skin) of other ingredients in the hand sanitizer, such as alcohol.
Antiseptics	Examples: chlorhexidine, quaternary ammonium salts, benzalkonium chloride, triclosan. These additional antimicrobials may be added as an option, but they are not required in order to provide enhanced and prolonged antimicrobial effect.
Foaming and thickening agents	Examples of foaming agents: sodium laureth sulphate, sodium dodecyl sulphate and coco-glucoside Examples of thickening agents: viscous liquids such as polyethylene glycol, polyacrylic acid and vegetable gums. Thickening and foaming agents, together with emollients (gels), increase the viscosity of the composition, thereby lowering the alcohol evaporation rate and increasing the exposure time that the alcohol is present on the skin.
Colourants	These are dyes and pigments used to impart colour to the finished product to make it appealing and attractive. Additionally, they may be used to create function appeal and portray a product as in tune with environment.
Fragrances	Fragrances give the sanitizer a pleasant scent.
Water, sterile or distilled	Sterilization/distillation process ensures that no viable microorganism is present in the water. Presence of water is a crucial factor to the microbicidal effectivity of the ethanol-water mixture. Very low alcohol concentration is inadequate to dissolve the microbial lipid cell membrane, whereas very high alcohol concentration rapidly coagulates the protein cover, preventing ethanol from penetrating the pathogen cell to reach the inner protein and nuclear materials.

Although liquid alcohol may kill microbes on contact, upon drying there is no means of killing or controlling microbial growth, whereas the slow drying (sticky) properties of alcohol gels impart persistent antimicrobial residual activity on the hand sanitizer. Unfortunately, these thickened compositions often result in a less than optimal aesthetic skin feel in use or upon rinsing. Prolonged skin contact with alcohol of high content may also dry and irritate the skin, and thickeners may trap dead skin and microbes on the surface of the skin. On the other hand, liquids give a cleaner, smoother, more moisturized feel, despite the increased difficulty in handling and applying the product [12].

For alcohol-based hand sanitizers, WHO recommends a concentration of 60–95% v/v ethanol or 2-propanol mixed with distilled water. Alcohol acts on microbes in the presence of water by making the organism cell membrane permeable leading to cytoplasm leakage, denaturing of proteins and eventually, cell lysis [8]. At higher concentrations (> 95% v/v) alcohol is not effective since microbial denaturing of proteins only takes place in the presence of water [13]. Alcohols with four carbons and more are hence, not recommended to be used as hand sanitizers since they are less soluble in water [2]. The use of ethanol in hand sanitizers is also of great health concern since, if abused (i.e., sanitizer ingestion to experience ethanol intoxication), it can cause alcohol poisoning. Several studies have also found that accidental ingestion of ethanol from hand sanitizers can induce intoxication and hypoglycaemia in children [14].

Alcohol-free hand sanitizer formulations contain benzalkonium chloride as the surfactant that primarily acts as the active antibacterial agent [15]. Alcohol-free hand sanitizers are also active against some of the viruses, fungi and protozoans [16]. However, alcohol-free hand sanitizers are aesthetically not pleasing because the surfactant that is found in them is not evaporative and as a result, once the hand sanitizer applied has dried, the surfactant does not readily evaporate, leaving hands wet [15]. Alcohol-free hand sanitizers act by disrupting the target organisms' cell membrane. Moreover, the compounds that are incorporated in alcohol-free hand sanitizers are used either in low or high concentrations [16]. At low concentration, they act by causing cytolytic leakage of cytoplasmic material. At high concentration, they cause bacterial cytoplasm coagulation as they target the carboxylic group [16]. Similarly, the viral envelope (as in coronaviruses) is the predominant target of alcohol-based hand sanitizers prior to reaching and disrupting the protein capsid, which protects the genetic material of the virus [10, 11]. Unfortunately, alcohol-based hand sanitizers have been found to be ineffective against non-enveloped viruses.

Ethanol has been shown to be effective against a variety of enveloped viruses, beginning at concentrations of 42.6% (w/w) [17]. Addition of acids to ethanol can substantially improve the virucidal activity against most viruses [17]. For example, a formulation with low alcohol content and citric acid can inactivate all enveloped and non-enveloped viruses [18]. Several studies demonstrate that 2-propanol is considerably less effective compared to ethanol against viruses [17], probably hence why the guide to local production of hand sanitizers by WHO which describes two formulations against SARS-CoV-2 based on ethanol and 2-propanol as active ingredients, shows a higher concentration of

required 2-propanol than ethanol [19]. Some studies have also shown that ethanol gel formulations, unless they have been specially formulated and tested are less efficacious than ethanol solution formulations [20], even though this has not yet been proven for SARS-CoV-2.

As previously indicated the global medical crisis as a result of the CoViD-19 pandemic has resulted in a great surge in the trade of hand sanitization products. This emergent situation is expected to continue for a considerable period of time until more efficient infection preventive measures become available, hence hand sanitizer demand will remain for an extended time. Unfortunately, many hand sanitizers have not been verified to meet the regulators' recommendations or that they are manufactured under the stipulated regulatory conditions. In addition, regulators lack verifiable information to ascertain the methods being used to prepare hand sanitizers at homes and to determine if these sanitizers are safe for use on human skin. As part of public awareness campaign and contribution to assist during the CoViD-19 pandemic, the project aimed to identify sanitizers available and used in the Johannesburg area that do not contain the recommended quality and alcohol content of ≥ 70%.

2. Materials And Methods

2.1. Preparation of Internal Standard (2% acetaldehyde)

Two millilitres (2 ml) of acetaldehyde (Sigma-Aldrich®, Germany) were added to a 100 ml volumetric flask. Deionized water was added to make up the volume to the mark.

2.2. Preparation of 2% stock standards

Two millilitres of each reagent (Sigma-Aldrich®) were added to a 100 ml volumetric flask. Deionized water was added to make up the volume to the mark. A stock of each of the following reagents was prepared; methanol, ethanol, 1-propanol, 2-propanol, isobutanol, 3-methyl-butanol and ethyl acetate.

2.3. Preparation of calibration standards

A calibration standard was prepared in a range of 0.1–1.8% by diluting the stock solution with deionized water. The standards were each prepared in a 10 ml headspace vial, capped and mixed well on a vortex mixer. The standards were then immediately placed onto the headspace auto sampler tray for analysis.

2.4. Preparation of Quality controls

A 2% quality control stock solution was prepared by adding 2 ml of alcohol (Sigma-Aldrich®, Germany) to a 100 ml volumetric flask and filling up to the mark with deionized water. Three quality controls at low (QC 1, 0.2%), medium (QC 2, 1.0%) and high level concentration (QC 3, 1.6%) were prepared from the stock solution. Each QC was prepared in a 10 ml headspace vial, capped with septa and aluminium crimp cap and mixed well on a vortex mixer. All 3 QCs were prepared in duplicate and positioned on the auto sampler tray for analysis after calibration standards and after every 5 duplicate samples.

2.5. Preparation of hand sanitizer samples

2.5.1 Preparation of liquid hand sanitizer samples

In a sterile polypropylene cup (urine container) was pipetted 350 µl sanitizer to which was added 25.65 ml deionized water. Then 900 µl of this solution was transferred to a 10 ml headspace vial to which 100 µl of internal standard was also added. The vial was capped and contents mixed thoroughly on a vortex mixer before analysis.

2.5.2 Preparation of gel hand sanitizer samples

In a sterile polypropylene cup on a weighing balance 10 g of deionized water was measured and 0.350 g of gel hand sanitizer was also added. The urine container was filled up with more deionized water until a mass of 25 g was reached. The cup was capped and shaken to mix contents well. Then 900 µl of this solution was pipetted into a 10 ml headspace vial to which was also added 100 µl of internal standard. The vial was capped and contents mixed on a vortexer before analysis.

2.6. Analysis of samples by Headspace Gas Chromatography connected to a Flame Ionisation Detector (HS-GC/FID)

Following sample preparation samples were immediately placed onto the headspace auto sampler tray (Agilent™ G1888) for analysis. The samples were analysed using a 6890N Agilent© gas chromatograph utilizing a flame ionisation detector. The column of choice was a Supelcowax ® column (L = 30 m, ID = 0.25 mm and film thickness = 0.5 µL) purchased from Sigma-Aldrich®.

2.7. Data acquisition & processing

Quantitation was performed using the Agilent® Open Lab CDS ChemStation® Edition for GC Systems, C.01.05 integration software, accompanying the GC system. A correlation coefficient (r^2) of more than 0.999 was obtained for the calibration curves.

2.8. Data Analysis

Results were analyzed using Microsoft® Excel®. Descriptive statistics using tables, mean and percentage was used to describe the data obtained.

3. Results

Ninety-four (94) samples of hand sanitizer were randomly collected around Johannesburg during the period March to June 2020. The samples consisted of fifty (50) gels and forty-four (44) liquids pictured in Fig. 1, in no particular order. Forty of the sanitizers (14 liquids and 26 gels) did not have their alcohol content stated on the container and only one sample was clearly indicated as alcohol-free (see Table 1). This sample set represents most of the hand sanitizer brands available and/or sold in retail stores, spaza shops and by individuals, that are in use in different households and various workplaces around Johannesburg during the CoViD-19 pandemic.

Of the 94 hand sanitizer samples collected, three sanitizer preparations were found to contain no alcohol, whereas the rest contained either ethanol or 2-propanol or a combination of these two (Table 2). By comparison, liquid formulations had on average less alcohol (56,38 ± 26.74% (v/v)) than the gel formulations (66,14 ± 20,95% (v/v)). Of the alcohol-containing sanitizers, 37 (41%) contained less than 60% v/v alcohol. Toxic alcohol denaturants (ethyl acetate and isobutanol) and other non-recommended alcohols (methanol, 1-propanol and 3-methyl-butanol) were also identified in some of these preparations. In fact, one hand sanitizer sample contained solely 1-propanol.

Table 2
Alcohol content of hand sanitizers collected around Johannesburg during the CoViD-19 pandemic.

Sample Code	Liquid/ Gel/ Aerosol	% Alcohol stated on container	Sanitizer Constituents (v/v %)								
			Methanol	Ethyl acetate	2-Propanol	Ethanol	1-Propanol	Isobutanol	3-Methyl-butanol	Total Alcohol	Total Ethanol + 2-Propanol
HS 1	Liquid	70	-	-	0,59	75,64	-	-	-	76,22	76,22
HS 3	Liquid	*n/s	1,67	-	78,18	6,14	-	-	-	85,99	84,32
HS 4	Aerosol	40	-	-	44,87	1,26	-	-	-	46,12	46,12
HS 8	Liquid	70	-	-	67,55	-	-	-	-	67,55	67,55
HS 10	Liquid	70	-	-	69,90	-	-	-	-	69,90	69,90
HS 18	Liquid	74	-	-	55,40	10,94	-	-	-	66,34	66,34
HS 21	Liquid	70	3,92	-	3,47	48,89	-	-	2,00	58,28	52,36
HS 24	Liquid	95	-	-	2,43	95,29	-	-	-	97,72	97,72
HS 29	Liquid	70	-	-	5,08	44,86	-	-	-	49,94	49,94
HS 33	Aerosol	70	3,95	-	19,10	16,12	-	-	-	39,18	35,23
HS 34	Liquid	70	-	-	-	68,49	-	-	-	68,49	68,49
HS 35	Liquid	n/s	-	-	41,78	1,83	-	-	-	43,61	43,61
HS 36	Aerosol	62	-	-	-	32,00	-	-	-	32,00	32,00
HS 37	Liquid	70	-	-	-	58,58	-	-	-	58,58	58,58
HS 38	Liquid	70	-	-	-	80,40	-	-	-	80,40	80,40
HS 40	Liquid	70	-	-	-	58,07	-	-	-	58,07	58,07
HS 41	Aerosol	70	-	-	61,09	7,20	-	-	-	68,29	68,29
HS 42	Liquid	n/s	-	-	-	-	-	-	-	0,00	0,00
HS 48	Liquid	70	-	-	-	-	59,58	-	-	59,58	0,00
HS 49	Liquid	70	-	-	-	72,15	-	-	-	72,15	72,15
HS 50	Liquid	n/s	-	-	-	85,49	-	-	-	85,49	85,49
HS 51	Liquid	70	-	-	-	83,51	-	-	-	83,51	83,51
HS 52	Liquid	n/s	-	-	48,82	-	-	-	-	48,82	48,82
HS 55	Liquid	70	-	-	74,36	6,18	-	-	-	80,55	80,55
HS 58	Aerosol	70	-	-	-	65,84	-	-	-	65,84	65,84
HS 59	Liquid	70	-	-	-	51,15	-	-	-	51,15	51,15
HS 61	Liquid	72	-	-	-	70,42	-	-	-	70,42	70,42
HS 64	Liquid	60	-	-	-	75,36	-	-	-	75,36	75,36
HS 65	Liquid	70	-	-	-	71,94	-	-	-	71,94	71,94
HS 67	Liquid	n/s	-	-	5,30	63,32	1,68	2,33	1,70	74,34	68,63
HS 68	Liquid	n/s	5,55	-	-	54,05	-	1,15	0,80	61,55	54,05
HS 71	Liquid	70	-	-	4,74	53,30	-	-	-	58,04	58,04
HS 72	Aerosol	70	-	-	4,03	63,67	-	-	-	67,70	67,70
HS 73	Liquid	75	-	-	2,73	16,99	58,75	-	-	78,47	19,72
HS 74	Aerosol	n/s	-	-	-	-	-	-	-	0,00	0,00

Sample Code	Liquid/ Gel/ Aerosol	% Alcohol stated on container	Sanitizer Constituents (v/v %)								
			Methanol	Ethyl acetate	2-Propanol	Ethanol	1-Propanol	Isobutanol	3-Methyl-butanol	Total Alcohol	Total Ethanol + 2-Propanol
HS 78	Liquid	n/s	-	-	-	-	-	-	-	0,00	0,00
HS 79	Liquid	n/s	-	-	2,15	19,50	-	-	-	21,65	21,65
HS 81	Aerosol	70	-	-	4,31	61,75	6,20	2,40	1,82	76,48	66,06
HS 83	Liquid	75	-	-	-	59,60	1,39	6,24	0,12	67,36	59,60
HS 84	Liquid	n/s	-	-	-	20,44	-	-	-	20,44	20,44
HS 88	Aerosol	80	-	-	2,06	82,04	-	-	-	84,10	84,10
HS 91	Liquid	n/s	1,50	-	-	16,67	-	-	-	18,17	16,67
HS 93	Liquid	n/s	-	-	-	87,88	-	-	-	87,88	87,88
HS 94	Liquid	n/s	-	-	89,85	5,88	-	-	-	95,72	95,72
STDEV											**26,74**
AVERAGE											**56,38**
HS 2	Gel	40	-	-	-	53,48	-	-	-	53,48	53,48
HS 5	Gel	n/s	-	-	-	64,17	-	-	-	64,17	64,17
HS 6	Gel	70	-	-	-	59,55	-	-	-	59,55	59,55
HS 7	Gel	n/s	-	-	53,90	2,11	-	-	-	56,01	56,01
HS 9	Gel	70	-	-	73,46	-	-	-	-	73,46	73,46
HS 11	Gel	70	-	-	59,37	4,06	8,81	-	-	72,23	63,43
HS 12	Gel	n/s	-	-	-	88,16	-	-	-	88,16	88,16
HS 13	Gel	n/s	-	-	-	70,75	-	-	-	70,75	70,75
HS 14	Gel	70	-	-	-	81,14	-	-	-	81,14	81,14
HS 15	Gel	n/s	-	-	-	67,05	-	-	-	67,05	67,05
HS 16	Gel	63	-	-	-	68,83	-	-	-	68,83	68,83
HS 17	Gel	n/s	-	-	-	73,89	-	-	-	73,89	73,89
HS 19	Gel	70	-	-	56,73	2,18	-	-	-	58,90	58,90
HS 20	Gel	n/s	-	-	3,31	17,61	8,04	3,31	-	32,26	20,92
HS 22	Gel	72	-	-	-	67,56	-	-	-	67,56	67,56
HS 23	Gel	65	-	-	-	65,00	-	-	-	65,00	65,00
HS 25	Gel	n/s	-	-	-	85,10	-	-	-	85,10	85,10
HS 26	Gel	n/s	-	-	-	90,32	-	-	-	90,32	90,32
HS 27	Gel	n/s	-	-	-	61,18	-	-	-	61,18	61,18
HS 28	Gel	n/s	3,04	16,04	2,15	45,97	5,61	2,07	1,44	76,32	48,12
HS 30	Gel	70	-	-	14,76	29,49	-	-	-	44,25	44,25
HS 31	Gel	65	-	-	-	66,53	-	-	-	66,53	66,53
HS 32	Gel	n/s	-	-	-	78,48	-	-	-	78,48	78,48
HS 39	Gel	n/s	-	-	-	85,12	-	-	-	85,12	85,12
HS 43	Gel	71	1,75	-	1,16	69,51	-	-	-	72,42	70,67

Sample Code	Liquid/ Gel/ Aerosol	% Alcohol stated on container	Sanitizer Constituents (v/v %)								
			Methanol	Ethyl acetate	2-Propanol	Ethanol	1-Propanol	Isobutanol	3-Methyl-butanol	Total Alcohol	Total Ethanol + 2-Propanol
HS 44	Gel	62	-	-	-	67,82	-	-	-	67,82	67,82
HS 45	Gel	70	-	-	52,61	-	-	-	-	52,61	52,61
HS 46	Gel	n/s	1,16			74,39				75,55	74,39
HS 47	Gel	62	-	-	0,33	55,06	-	-	-	55,39	55,39
HS 53	Gel	n/s	-	-	-	2,55	47,09	-	-	49,65	2,55
HS 54	Gel	n/s	-	-	-	98,65	-	-	-	98,65	98,65
HS 56	Gel	70	-	-	-	79,42	-	-	-	79,42	79,42
HS 57	Gel	n/s	-	-	-	75,04	-	-	-	75,04	75,04
HS 60	Gel	n/s	-	-	-	61,22	-	-	-	61,22	61,22
HS 62	Gel	70	-	-	0,30	69,22	-	-	-	69,51	69,51
HS 63	Gel	alcohol-free	-	-	-	0,51	-	-	-	0,51	0,51
HS 66	Gel	70	1,98	-	-	75,72	-	-	-	77,69	75,72
HS 69	Gel	n/s	-	-	-	58,18	-	-	-	58,18	58,18
HS 70	Gel	70	-	-	-	69,24	-	-	-	69,24	69,24
HS 75	Gel	n/s	-	-	-	69,39	-	-	-	69,39	69,39
HS 76	Gel	70	-	-	-	62,87	-	-	-	62,87	62,87
HS 77	Gel	n/s	-	-	-	68,12	-	-	-	68,12	68,12
HS 80	Gel	75	-	-	1,37	67,21	-	-	-	68,58	68,58
HS 82	Gel	70	2,00	-	0,93	61,77	-	-	-	64,70	62,70
HS 85	Gel	n/s	-	-	-	99,18	-	-	-	99,18	99,18
HS 86	Gel	n/s	-	-	-	88,40	-	-	-	88,40	88,40
HS 87	Gel	n/s				90,90				90,90	90,90
HS 89	Gel	70	-	-	64,83	4,15	-	-	-	68,98	68,98
HS 90	Gel	n/s	-	-	-	97,49	-	-	-	97,49	97,49
HS 92	Gel	70	-	-	0,30	69,22	-	-	-	69,51	69,51
STD DEV											**20,95**
AVERAGE											**66,14**

***n/s: not stated**

4. Discussion

Results from this study indicate that there are about similar number of gel sanitizers in existence around Johannesburg as the liquid formulations (50 gels versus 44 liquids). By comparison, liquid formulations (56,38 ± 27%) had on average less alcohol than the gel formulations (66,14 ± 20,95%).

While more (56%) brands of hand sanitizer in this study contained the recommended concentration of alcohol, there were also many (44%) substandard and possibly subpotent preparations. Unfortunately, tests to determine if any of the analyzed sanitizers with lower alcohol content than is recommended had any of the virucidal activity enhancing ingredients, such as acids, were beyond the scope of this study. The study also found that 30% (10 gels and 9 liquids) of the analyzed sanitizers contained ≥ 80% alcohol, even though alcohol concentrations higher than

80% (v/v) are known to be less potent because proteins are not easily denatured in the absence of water [20]. Moreover, it was found that some sanitizers contained, in addition to ethanol or 2-propanol, some toxic ingredients, such as ethyl acetate, methanol and 1-propanol. This is worrying because even if a hand sanitizer contains enough alcohol as recommended or contains ingredients that enhance its virucidal activity in case of low alcohol content, the presence of toxic ingredients renders the preparation harmful and unfit for human use. It is for this reason that it is recommended that all consumers (workplaces and the public in general) be aware of untrustworthy brands of hand sanitizer supplying substandard and possibly sub-potent sanitizer preparations or sanitizers with toxic ingredients. Unknowingly, using a hand sanitizer with no virucidal activity may give one a false sense of security, while those using sanitizers containing toxic ingredients are likely to suffer from the associated risks. For example, exposure to methanol through both ingestion and transdermal absorption, if left untreated, can be extremely dangerous, leading to significant disability and death [21].

The US FDA is therefore continually adding certain hand sanitizers found to contain toxic ingredients to import alerts, to stop these products from legally entering the U.S. market [22], while the South African Bureau of Standards (SABS) has also warned consumers about some unscrupulous manufacturers that are making false claims that their products are SABS-certified [23].

5. Conclusion

Just like several other countries around the world, South Africa (SA) has relaxed legislation to make it easier for local businesses to rapidly produce alcohol-based hand sanitizers to meet the great surge in demand for hand sanitization products during the SARS-CoV-2 outbreak. However, those producing hand sanitizers are still advised to follow the WHO guidelines, and avoid using poor alcohol quality which is likely to contain toxic substances. The SA public is also advised to remain alert to media reports that continually keep surfacing about hand sanitizer brands in violation of the SABS guidelines [24, 25], by producing sanitizer preparations that are subpotent or contain toxic substances. Even if toxic substances are just traces, the typical frequent use of hand sanitizer products throughout the day can result in very high total exposure with consequent adverse health effects.

Declarations

Availability of Data and Materials

The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Authors’ Contributions

PM conceptualised the study and wrote the manuscript; BS, TM and BD performed data collection and analysis. PP assisted with analysis and results interpretation. BK reviewed and edited the manuscript, and supervised the team. All authors contributed in the finalization of the manuscript.

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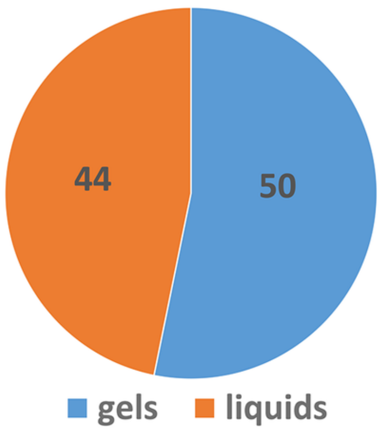
Figures

(a)



(b)

Figure 1

(a) A picture of hand sanitizers collected around Johannesburg, (b) comprising of gels and liquids.