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Test of the Efficacy of Disinfectant Commonly Use in Homes and Health Facilities in Ekpoma, Nigeria

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Abstract

This study was conducted to test the efficacy of disinfectants commonly used in homes and health facilities in Ekpoma and compare Branded and unbranded disinfectants available in stores and the Market in Ekpoma, Edo State, on some selected microorganisms. This study is imperative because many products are available to some due to the high cost of living. It is a way of earning a living and breaking even, the target is usually moving products. Lysol and Jik (Branded and non-branded) were bought in the market from Ekpoma and analysed in Irrua Specialist Teaching Hospital using the Tube Dilution Method. In this study, 3% Lysol had no growth, 5% Jik branded had few colonies of microbes, and 5% Jik non-branded had heavy growth of colonies after 24 hours of disinfection. The minimum bactericidal concentration (MBC) of Lysol and Jik Branded was 0.5% and 2.0% respectively, while Jik non-Branded was ineffective.

Keywords: Disinfectant, Homes, Health Facility, Lysol, Jik

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1. Introduction

Disinfectants play a crucial role in infection control by killing or inactivating microorganisms, including bacteria, viruses, and fungi, on surfaces and objects. This reduces the risk of transmission and helps prevent the spread of infections in various settings, including healthcare facilities, homes, and workplaces. The purpose of routine or targeted disinfection of inanimate surfaces is to kill or irreversibly inactivate pathogens to an extent which prevents subsequent infection transmission. Disinfection may be required in the following areas, "high-touch" (i.e. frequently touched) surfaces near patients, surfaces where contamination is assumed, surfaces with visible contamination (blood, pus, excrements), terminal disinfection in rooms or areas where infected or colonized patients were treated or nursed, or in outbreak situations (Gebel *et al*., 2013).

A wide range of disinfectants are available commercially in the market with Branded and unbranded products, but an ideal disinfectant should have a broad antimicrobial spectrum, should be non-irritating, less toxic, noncorrosive and inexpensive. Despite best efforts to identify and eliminate infectious microorganisms, they continue to emerge and re-emerge, and these pathogenic bacteria significantly contribute to human illness and death, especially as a result of infections (NIH, 2007). The emergence of resistant microorganisms in hospitals and the community is causing problems for both the treatment of patients and infection control (CDC, 2024). In a recent major review of the control of these organisms, many authorities have reiterated the key role of disinfectants (Gebel *et al*., 2013). Major consideration in selecting disinfectant compounds should be based on the job they are expected to do, thus disinfectants used in hospitals, industries, laboratories and homes must be tested periodically to ascertain their potency validation which is defined as establishing documented evidence that a disinfection process will consistently remove or inactivate known or possible pathogens from inanimate objects (Sridhar, 2012).

Evidence supports the important role of environmental cleaning in controlling the transmission of organisms (e.g. *Staphylococcus aureus*, Vancomycin-resistant *Enterococci*, Norovirus, *Clostridium difficile* and *Acinetobacter*), especially in hospitals and healthcare settings (Dancer, 2009). Many factors can affect the use of disinfectant despite that the product is produced according to international standards, these factors include the number of microorganisms and their location, the more the number of microorganisms the greater the time the disinfectant will require to completely remove the microorganisms from the surface or environment the innate mechanism of the microorganism can also affect the efficacy of the disinfectant like spore-forming organism and organisms waxy cell wall may require a longer time for the disinfectant to work or act, it may also require a higher concentration of the disinfectant for complete disinfection (Favero & Bond, 2001; Russell & McDonnell, 2001; Russel, 2004; Russell, 2021). Other factors may include physical and chemical factors, pH, relative humidity, water and temperature (Favero & Bond 2001). Organic and inorganic matter biofilm formation can also affect the efficacy of disinfectant (Vickery *et al.,* 2004; Dazzo, 2005; Mbajiuka *et al.,* 2015).

Chlorine And Chlorine Compounds

Hypochlorite, the most widely used chlorine disinfectant, is available as liquid (e.g., sodium hypochlorite) or solid (e.g., calcium hypochlorite) (Jakobsson *et al.,* 1991). The most prevalent chlorine products are the aqueous solutions available in 5.25% – 6.15% sodium hypochlorite, usually called household bleach (Rutala & Weber, 1997). They have a broad spectrum of antimicrobial activity, do not leave toxic residues, are unaffected by water hardness, are inexpensive and fast-acting, remove dried or fixed organisms and biofilms from surfaces, and have a low incidence of serious toxicity (Jakobsson *et al.,* 1991). Sodium hypochlorite at the concentration used in household bleach (5.25 - 6.15%) can produce ocular irritation or oropharyngeal, oesophagal, and gastric burns (Weber & Rutala, 1997). Other disadvantages of hypochlorites include corrosiveness to metals in high concentrations (> 500 ppm), inactivation by organic matter, discolouring or "bleaching" of fabrics, release of toxic chlorine gas when mixed with ammonia or acid (e.g., household cleaning agents) and relative stability (Rutala *et al*., 1998). The microbicidal activity of chlorine is attributed largely to undissociated hypochlorous acid (HOCl). The dissociation of HOCI to the less microbicidal form (hypochlorite ion OCl-) depends on pH (Hoffman *et al*., 1981). The disinfecting efficacy of chlorine decreases with an increase in pH that parallels the conversion of undissociated HOCI to OCl-329, (Dychdala, 2001). A potential hazard is the production of the carcinogen bis (chloromethyl) ether when hypochlorite solutions contact with formaldehyde and the production of the animal carcinogen trihalomethane when hot water is hyperchlorinated (Gamle, 1977; Helms *et al*., 1987).

Alternative compounds that release chlorine and are used in the health-care setting include demand-release chlorine dioxide, sodium dichloro isocyanurate, and chloramine-T, based on the advantage that these compounds have over hypochlorites, which is that they retain chlorine longer and so exert a more prolonged bactericidal effect (Coates, 1988).

The exact mechanism by which free chlorine destroys microorganisms has not been elucidated, but inactivation by chlorine can result from several factors (Rutala *et al*., 1998; Garba & Rusin, 2001). The actual microbicidal mechanism of chlorine might involve a combination of these factors or the effect of chlorine on critical sites (Garba & Rusin, 2001).

Low concentrations of free available chlorine (e.g., HOCl, OCl-, and elemental chlorine - Cl2) have a biocidal effect on mycoplasma (25 ppm) and vegetative bacteria (< 5 ppm) in seconds in the absence of an organic load (Lee *et al*., 1985; Dychdala, 2001). A concentration of 100 ppm will kill >99.9% of B. atrophaeus spores within 5 minutes (Williams & Russell, 1991) and destroy mycotic agents in <1 hour (Dychdala, 2001). Acidified bleach and regular bleach (5,000 ppm chlorine) can inactivate 106 Clostridium difficile spores in <10 minutes (Dyas & Das, 1985). Several studies have demonstrated the effectiveness of diluted sodium hypochlorite and other disinfectants to inactivate HIV (Sattar & Springthorpe, 1991). Chlorine (500 ppm) showed inhibition of Candida after 30 seconds of exposure (Silverman *et al*., 1999). Sodium dichloroisocyanurate at 2,500 ppm available chlorine is effective against bacteria in the presence of up to 20% plasma, compared with 10% plasma for sodium hypochlorite at 2,500 ppm (Bloomfield & Miller, 1989).

Phenol is an antiseptic and disinfectant and comes in different preparations, thymol, xylenol, o-phenyl-phenol (OPP) and triclosan. It is active against a wide range of micro-organisms, including some fungi and viruses, but is only slowly effective against spores. Phenol has been used to disinfect skin and to relieve itching. Phenol is a toxic compound whose vapours are corrosive to the skin, eyes, and respiratory tract.

2. Method

This study was set to analyse common disinfectants sold in Ekpoma. Two different brands of disinfectant were chosen to represent Lysol and hypochlorite-based disinfectant. Three samples of branded and unbranded Lysol and three samples of branded and unbranded hypochlorite base disinfectant were bought for the study. The disinfectant was labelled as Branded and unbranded for both Lysol and hypochlorite. A series of increasing concentrations of the disinfectants was obtained using serial dilution using sterile peptone water, disinfectant, sterile normal saline and a broth containing a combination of *Staphylococcus aureus*, *Serratia* spp and *Escherichia coli*, *Proteus* spp and *Candida* spp. It was collected from Irrua Specialist Teaching Hospital, and the analysis was done using the method described by Al-Talib *et al*., (2019)

Tubes	**Positive control**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Negative control**
Sterile peptone water(ml)	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0	0.5	0
Disinfectants (ml)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Sterile distilled water(ml)	-	-	-	-	-	-	-	-	-	-	-
Total volume (ml)	5	5	5	5	5	5	5	5	5	5	5
Concentration (%)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0

Micropipettes were used to deliver 10µL of well-mixed overnight broth culture into the different concentrations of the respective disinfectant in the respective test tubes and were incubated at 37˚C for 24 hours. The tubes were observed for growth and were recorded. Because some of the disinfectants had colour, it was difficult to read the MIC. All the tubes were sub-cultured to determine the minimum bactericidal concentration on the nutrient agar plate, the concentration that shows no bacterial growth was recorded as the MBC while the tubes that had one or more colonies before the MBC tube was reported as the MIC.

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3. Results

Table 1: Disinfectants Testing against selected organisms

Tubes	Positive control	2	3	4	5	6	7	8	9	10	Negative control
Concentration (%)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Branded disinfectant 1	G	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Branded disinfectant 2	G	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Branded disinfectant 3	G	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Unbranded disinfectant 1	G	G	G	NG	NG	NG	NG	NG	NG	NG	NG
Unbranded disinfectant 2	G	G	G	G	G	NG	NG	NG	NG	NG	NG
Unbranded disinfectant 3	G	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG

Key: G= Growth; NG= No growth

Table 2: Success and Failure of Disinfectants

	Success	Fail	Total	Fisher's Exact Test
Branded	27	0	27	p=0.0004
Non-branded	21	6	27	**P<0.05**
Total	48	6	54	

4. Discussion

The use of disinfectants in homes, hospitals, medical laboratories and in hand washing is important to combat hospital-acquired infections, prevent human-to-human transmission of infectious agents and also remove infectious materials or organisms from surfaces. This can only be achieved by using a potent disinfectant at the required concentration that will inactivate the pathogen. In Nigeria report of the presence of fake soap and Dettol in the market and NAFDAC destroyed a total of N120bn worth of fake products in six months (Adejoro, 2024) another report has it that NAFDAC seized fake soap, Dettol, disinfectant and unregistered chemical in Anambra (Consumer, 2025) these fake products pose serious health risk as unsuspecting consumers may use them for hygiene and medical purposes believing them to be genuine, when this disinfectant finds their way into our homes and health facilities it thwart the effort of government in infection control. This study evaluated and compared the practically achieved disinfection efficacy of some branded and unbranded disinfectants available in Ekpoma on microbial load.

Lack of sensitivity of the isolate to the disinfectant could be attributed to three main factors; Degradation of the disinfectant during storage, Storage temperature of the disinfectant, and

Faking of the disinfectant by the producer. Faking of the disinfectant is another important factor that can lead to the failure of the disinfectant. Sometimes the percentage potency of the disinfectants is far below the claimed standard by the manufacturers (Cardoso *et al*., 1999). The end users rely on the information provided by the manufacturers to make dilution of the product, thereby over-diluting the product, which renders it ineffective.

A wide range of disinfectants is available commercially that undergo extensive testing in controlled environments before market release. However, often, the products and procedures as described in the literature may not be able to adequately disinfect or decontaminate items when the surfaces have been contaminated with highly resistant or unusual organisms, or if the bioload of microorganisms is very heavy. The matter may be further complicated by the quality of environmental hygiene because of dust and other organic matter. When choosing a disinfectant, it may be necessary to know the expected number and the types of organisms likely to be present on the surface. The disinfectant must be selected based on its ability to be effective against the prevalent pathogenic microorganisms that can be transmitted by direct or indirect contact with the environment (Kawamura-Sato *et al*., 2010). An ideal disinfectant should have a broad antimicrobial spectrum, and should be non-irritating, less toxic, noncorrosive and inexpensive (Rutala & Weber, 2001).

From this study, we found that all the branded disinfectants showed good results with the MBC less than 0.05% in all three tested disinfectants. This result was encouraging as it showed that despite the presence of fake products in the country Ekpoma still had the original disinfectant in its market, but this cannot be said about the unbranded disinfectant, because of the three unbranded disinfectants tested, only one passed the test, showing the risk of buying unbranded disinfectant. When the result was tested statistically using Fisher's Exact Test $p<0.05$, showing that there is a significant difference between the two types of disinfectants. One of the features predominant in the three products was that there was no traceable address on the product, making it impossible for regulatory agencies to track them and see their production line. This finding is important for consumers to know that buying a branded disinfectant is better than buying the unbranded which are cheaper in the market. From the result of this study, Hospitals, wards, clinics, and medical laboratories should buy branded disinfectant. The limitation of this study is that it was not possible to test disinfectant from the majority of the stores, so we recommend periodic checks of all disinfectant use in health settings to help in infection control management.

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Availability of Data and Materials

The authors declare that they have no conflicts of interest.

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Competing Interests

The authors declare no conflicts of interest

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