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# Soaps and infection control: From chemistry to microbiology

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## Abstract:

**CONTEXT:** Soap and water cleaning of hands and body surfaces is one of the primary aspects of infection prevention and control. A systematic study of commonly used soaps is lacking.

**AIMS:** To investigate: (a) whether the so-called medicated soaps have a composition which is significantly different from ordinary soaps, (b) whether the ingredients responsible for enhanced antimicrobial activity posed any health risk and (c) whether the medicated soaps offered any specific advantages over non-medicated soaps.

**SETTINGS AND DESIGN:** Study was done with soaps available in Indian market, used predominantly in community settings but also in hospitals.

**MATERIALS AND METHODS:** Chemical composition was checked from package labels. No chemical or microbiological tests were done to verify actual composition against stated composition. Maximum retail prices as mentioned on the pack label were noted.

**STATISTICAL ANALYSIS USED:** None.

**RESULTS:** Soaps contain a multiplicity of ingredients. Exact composition is unknown as none of the soaps studied mentioned percentages. A number of antimicrobial agents were identified in soaps, which included salts of ethylenediaminetetraacetic acid, sodium chloride, triclocarban, triclosan, cresol compounds and certain quaternary ammonium compounds. No clear advantage was noted of the so-called 'medicated soap' over 'non-medicated soaps' in terms of ingredients or their actions. Certain medicated soaps may contain ingredients which may have a deleterious effect on microbial flora (generation of resistance) or human health (enzyme inhibition).

**CONCLUSION:** While purchasing soaps either for domestic use or for hospital infection control, we need to pay due attention to its composition.

## Keywords:

Chemistry, infection prevention, microbiology, safety, soaps

## Introduction

Soap and water cleaning of hands and body surfaces is one of the primary aspects of infection prevention and control.<sup>[1]</sup> Soaps contain surface-active agents, which reduce surface tension and help cleaning oily substances and dirt. Some soaps may contain ingredients which could have antibacterial activity. These may be described as medicated soaps.<sup>[2]</sup> Purpose of the present study was to investigate: (a) whether the so-called medicated soaps have a composition which

is significantly different from ordinary soaps, (b) whether the ingredients responsible for enhanced antimicrobial activity posed any health risk and (c) whether the medicated soaps offered any specific advantages over non-medicated soaps.

The study was conducted as part of an exercise for determining the preferred soap (meant for personal use of patients) for the hospital pharmacy in a cancer hospital in eastern India.

## Materials and Methods

Some commonly used soaps available in the Indian market were chosen including

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one medicated soap present at the hospital pharmacy. The ingredient of various soaps as mentioned over the packet was studied (maximum retail prices were from the period 2013-2014, when the study was done). PubMed and Google search engines were used to find relevant references with respect to ingredient known to have antimicrobial activity. No chemical or microbiological tests were done to verify actual composition against stated composition.

## Results

Study showed that soaps contain many ingredients [Table 1]. Exact composition is unknown as none of the soaps studied mentioned percentages or proportions. A number of antimicrobial agents were identified in soaps, which included salts of ethylenediaminetetraacetic acid (EDTA), sodium chloride, triclocarban (TCC), triclosan,

cresol compounds, certain quaternary ammonium compounds, flower and leaf extracts. The antimicrobial effect of leaf and flower extracts has not been assessed in this analysis. Certain important aspects of the ingredients known to have antimicrobial activity were as follows:

### Sodium chloride

Activity of this compound is higher against Gram-negative bacteria than for Gram-positive bacteria (present in Lifebuoy, Margo, Lux and Dove).<sup>[3]</sup>

### Ethylenediaminetetraacetic acid

This compound has broad-spectrum antibacterial activity. Certain salts of EDTA have activity against metallo-beta-lactamase producers (such as some carbapenemase-producing Gram-negative bacilli) (present in most soap studied except Margo).<sup>[4]</sup>

**Table 1: Comparative study of some common “medicated” and “non-medicated” soap in India**

Soap, product type, manufacturer, weight/volume, maximum retail price	Ingredients with significant antimicrobial activity	Other ingredients
Antibacterial soap, Bar, Apollo Pharmacy, 75 g, Rs. 17 (\$0.27)	Triclosan, EDTA	Colour, noddle, perfume, titanium dioxide, talc, water
Dettol, Bar, Reckitt Benckiser, 90 g, Rs. 19 (\$0.30)	Triclocarban, disodium EDTA, Sodium chloride	Acetic acid, aqua, talc, CI 42090, CI 42045, cyclodextrin, etidronic acid, glycerine, palm acid, palm kernel acid, perfume, PEG-7 amodimethicone, sodium 14-16 olefin sulfonate, sodium palm kernelate, sodium palmate, tetrabutylammonium bromide, titanium dioxide, trideceth-10
Dettol, Liquid, Reckitt Benckiser, 225 mL, Rs. 64 (\$1.03)	Isopropyl alcohol, P-chloro-m-cresol, disodium EDTA, Sodium chloride	Aqua, CI 11710, CI 12085, cocamide MEA, cocamidopropyl betaine, disodium EDTA, elaeis guineensis (palm), etidronic acid, glycol stearate, kernel oil, palm stearin fatty acid, parfum, pinus palustris oil, potassium chloride, potassium hydroxide, preservatives, propylene glycol, sodium C 14-16 olefin sulfonate, zinc stearate
Dove, Bar, Hindustan Unilever Limited, 100 g, Rs. 25 (\$0.40)	Sodium chloride, Tetrasodium EDTA	Citric acid, cocamidopropyl betaine, glycerine, lauric acid, perfume, sodium cocoyl isethionate, sodium isethionate, sodium palm kernelate, sodium palmitate, sodium stearate, stearic acid, tetrasodium etidronate, titanium dioxide, water, zinc oxide
Lifebuoy, bar, Hindustan Unilever Limited, 70 g, Rs. 10 (\$0.16)	Triclocarban, sodium chloride, tetrasodium EDTA	CI 11680, CI 12490, curcuma aromatica root oil, glycerine, glyceryl laurate, methylchloroisothiazolinone, methylisothiazolinone, pentasodium pentetate, perfume, sodium 14-18 olefin sulfonate, sodium carbonate, sodium palm kernelate, sodium palmate, talc, tetrasodium etidronate, water
Lifebuoy, liquid, Hindustan Unilever Limited, 215 mL, Rs. 50 (\$0.80)	Triclocarban, tetrasodium EDTA	BHT, CI 45100, cocamidopropyl betaine, curcuma aromatica root oil, DMDM hydantoin, etidronic acid, glycerine, glyceryl laurate, glycol distearate, perfume, hydroxypropyl methylcellulose, lauric acid, myristic acid, palmitic acid, pentasodium pentetate, potassium chloride, potassium hydroxide, sodium carbonate, sodium laureth sulfate, water
Lux, Bar, Hindustan Unilever Limited, 100 g, Rs. 22.50 (\$0.36)	Sodium chloride Tetrasodium EDTA	Camellia sinensis leaf extract, CI74160, CI74260, citric acid, flower extracts, glucose, glycerine, lauric acid, leaf extracts, methylchloroisothiazolinone, methylisothiazolinone, mica, propylene glycol, sea salt, silica, sodium palm kernelate, sodium palmate, tetrasodium etidronate, tin dioxide, titanium dioxide, water
Margo, Bar, WF India Ltd, 75 g, Rs. 18 (\$0.29)	Sodium chloride, Sodium soap of neem oil	Aqua, CI61565, CI74260, disodium etidronate, disodium etidronate, glyceryl monostearate, hard paraffin, lauric acid, lanolin, perfume, petroleum jelly, sodium palm kernelate/cocoate, sodium palmate, talc, Vitamin E acetate
Savlon, Bar, Johnson and Johnson Ltd, 75 g, Rs. 21 (\$0.34)	Triclosan, disodium EDTA, Sodium chloride	CI 12150, CI 47000, disodium EDTA, disodium etidronate, fragrance, glycerine, sodium palm kernelate, sodium palmate, water

Prices in Indian Rupees and US dollars. EDTA: Ethylenediaminetetraacetic acid

### Triclosan

High-level tolerance to triclosan may play a role in antibiotic resistance in certain bacteria (present in Apollo Pharmacy antibacterial soap and Savlon soap).<sup>[5,6]</sup>

### Triclocarban

This is a disinfectant and is a potent inhibitor of the enzyme epoxide hydrolase (sEH) (present in Lifebuoy [bar + liquid] and Dettol bar soap).<sup>[7]</sup> Epoxide hydrolase is distributed in a number of organs and tissues including the liver, kidney and brain.<sup>[8]</sup>

## Discussion

Cleanliness is an essential part of infection control measures. Soap and water are basic components used in cleaning practices. However, the selection of soap and water of appropriate quality is not always done with diligence. The effect of water on its own is significant, and according to one study, it was more compared to liquid soap alone or Savlon in water.<sup>[1]</sup> Washing hands or body parts with clean and chemically and microbiologically safe water seems to be fundamental in the cleaning process taking away 80%–90% of bacterial and viral load.<sup>[1]</sup>

The active ingredients of soaps vary. In this study, the exact composition (in terms of proportions or weights) was available in none of the soaps. Some soaps may contain substances which cause skin irritation.<sup>[9]</sup> Certain medicated soaps may contain ingredients which may have a deleterious effect on microbial flora (generation of resistance) or human health (enzyme inhibition).<sup>[7-13]</sup> Side effects caused by soaps may differ. In one study, Lifebuoy soaps had the highest erythema score.<sup>[9]</sup>

The use of antibacterial agents in the soaps seems to be widespread. In our study, five out of nine soaps reviewed found the ingredients to contain either triclosan or TCC. This is similar to a study done in the United States where 45% of surveyed soaps were found to contain antibacterial agents.<sup>[14]</sup> No clear advantage was noted for the so-called 'medicated soap' over 'non-medicated soaps' in terms of ingredients or their actions. Dettol and Lifebuoy soaps have similar compositions with the extra presence of sodium chloride in Lifebuoy soap. Sodium chloride is known to have an inhibitory action on Gram-negative bacilli. However, many non-medicated soaps also have ingredients which are similar. Savlon may contain different ingredients in different formulations and countries (Triclosan in Savlon soaps in India and chlorhexidine in Savlon solution abroad).<sup>[1]</sup> If we are to choose amongst the medicated soaps, we should avoid those containing Triclosan (because there is some

evidence that they can lead to antibiotic resistance in Gram-negative bacilli).<sup>[6]</sup>

The current study is based on literature review from the package labels on soaps and information available in medical literature. It does not involve actual microbiology experiments done with the soaps that have been discussed. This is a limitation of this study. The primary aim of the current literature review is to increase awareness in the medical, scientific community and the lay public. Performing practical microbiology experiments would give us a better understanding and has been done in a study from Saudi Arabia and Egypt which reported that Lifebuoy antibacterial handwash (containing TCC) and Palmolive hygiene handwash (containing unspecified 'natural' active ingredients) were superior (in terms of microbiological efficacy in reducing bacterial counts *in vitro*) compared with other handwashes, whereas amongst the soaps, CAREX was the superior brand.<sup>[15]</sup> The same study also generalised that the TCC-containing handwashes seemed to be more effective than chloroxylenol-containing handwashes. However, it also added that TCC has also been shown to have significant absorption into the human body after showering and may have some effects in inhibiting human enzymes.<sup>[15]</sup>

Many questions remain unanswered at the end of the study. These include (a) what is the exact composition of soaps, (b) are the ingredients which are potentially harmful present in soaps within acceptable limits and (c) what are the long-term consequences of their use? The selection of soaps unlike antibiotics or disinfectants is often not done based on scientific merits and demerits. Advertising, availability and individual perceptions and preferences play a major role in selection. It is important that in the process of selection of soaps either by healthcare administrators for institutional use or by others for domestic use, scientific understanding overrides cosmetic perceptions. This may ensure that undesirable effects are minimised, and expensive materials with no real additional advantage are not purchased. Bar soaps although not commonly used in developed countries are still widely used in developing countries because of low cost (note in the current analysis, liquid soaps were more expensive per pack than bar soaps) and long duration cultural familiarity.

While we select our soaps, it appears that economic, cosmetic, social consciousness and cultural considerations play a more dominant part than hard scientific facts. This needs to change, and regulations need to be more stringent with regard to safety and stated efficacy of soaps. The current study we hope would help to increase awareness amongst soap users in India.

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## Conflicts of interest

There are no conflicts of interest.

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