

# Assessment of Household Detergents: A Comparative Study on pH, Solubility, Surface Activity, and Cleaning Action

<sup>1</sup>Swati Vilhekar, <sup>2</sup>Aditya Unavane

<sup>1</sup>Assistant Professor

<sup>1</sup>Department of Chemistry

<sup>1</sup>The Institute of Science, Mumbai, India

<sup>1</sup> [swati.vilhekar1984@gmail.com](mailto:swati.vilhekar1984@gmail.com)

*Abstract*— Detergent powders are widely used in Indian households, yet their actual performance often differs from the claims made during marketing. In this study, six commonly available brands—Rin, Wheel, Henko, Surf Excel, Tide, and Ariel—were evaluated on several physicochemical and cleaning parameters. The analysis included pH measurement, solubility, foaming stability, surface tension, conductivity, critical micelle concentration (CMC), and practical cleaning action on stained fabrics. Results revealed that all tested detergents were alkaline in nature and highly soluble, though variations were observed in residue content and foaming ability. Significant differences in surface tension and CMC values highlighted the role of surfactant composition in overall cleaning efficiency. Among the tested products, Surf Excel and Ariel consistently demonstrated superior performance across multiple parameters. The findings provide useful insights for consumers in selecting appropriate detergents and contribute to understanding the relationship between formulation and cleaning action.

(*Key words*: Detergent, Surface tension, Foaming stability, Critical micelle concentration, Cleaning performance, Solubility)

## I. INTRODUCTION

The detergent industry plays a vital role in everyday life, with household cleaning products being an essential commodity in almost every home. In India, the demand for detergents has increased significantly since the 1980s, largely driven by population growth and rising consumer expectations [1]. Today, the market is segmented into premium, mid-priced, and mass-market categories, with the majority of households relying on the latter two due to affordability and accessibility [2].

Alongside increasing demand, the competition among detergent manufacturers has intensified. Companies often use persuasive marketing strategies, emphasizing features such as “extra whitening,” “quick stain removal,” or “long-lasting freshness,” which may not always reflect actual performance [3]. Moreover, some formulations have raised health concerns, particularly those containing harsh chemicals that cause skin irritation [4]. Such challenges have led consumers to prefer brands with a long-standing reputation for safety, effectiveness, and trust [5].

From a scientific perspective, detergent performance is influenced by several physicochemical properties, including solubility, alkalinity, foaming ability, surface tension, and critical micelle concentration (CMC) [3]. These factors not only determine stain removal efficiency but also reflect the underlying surfactant chemistry. A systematic comparison of popular detergent brands on these parameters is therefore valuable, both for consumers seeking reliable products and for researchers interested in surfactant behaviour in applied chemistry.

The present study evaluates six commonly used detergent brands—Rin, Wheel, Henko, Surf Excel, Tide, and Ariel—based on key physicochemical characteristics and cleaning action. The findings aim to bridge the gap between marketing claims and actual product performance while providing insights into the role of surfactant properties in determining cleaning efficiency.

## MATERIAL AND METHOD

### Selection of Samples

Six detergent powders from different companies—Rin, Wheel, Henko, Surf Excel, Tide, and Ariel—were selected for this study. These brands were chosen as they represent the mid-priced segment, are widely used in Indian households, and are easily available in the market. Recently manufactured packets were procured to ensure accuracy of results.

## Composition of Surfactants

The list of surfactants used in each detergent was reviewed to understand differences in formulation and their influence on cleaning performance. Surf Excel and Tide Plus primarily contain sodium silicate, Ariel contains sodium dodecylbenzene sulfonate, while Wheel, Rin, and Henko include sodium silicate along with sodium sulphate.

## Experimental Conditions

All experiments were conducted at room temperature under controlled laboratory conditions. The procedures followed for each parameter are described below.

**1. Solubility:** A 2% (w/v) solution of each detergent was prepared in distilled water using a conical flask. The solution was heated to 40 °C for 3 minutes and then allowed to cool for 2 minutes. The cooled solution was filtered using pre-weighed Whatman No. 1 filter paper under vacuum through a Buchner funnel. The filter papers with retained residues were dried in an oven at 60 °C for 8 hours until a constant mass was obtained. The final weight difference was used to determine the insoluble residue.

**2. pH Measurement:** Approximately 0.02 g of each detergent sample was dissolved in distilled water, and the pH was measured using a calibrated pH meter. Standard buffer solutions of pH 4, 7, and 10 were used to calibrate the instrument before measurements.

**3. Surface tension:** The surface tension of detergent solutions (0.05 g in 100 ml distilled water) was determined indirectly through viscosity measurements using a viscometer. The reduction in surface tension was correlated with the cleaning effectiveness of each detergent.

**4. Foaming Stability:** Foaming stability was assessed by preparing 0.05% (w/v) solutions of each detergent in test tubes. The solutions were shaken 10 times uniformly, and the time taken for a 2 cm foam layer to disappear was recorded.

**5. Cleaning action:** White cotton cloth pieces were stained with substances such as mud, tea, ketchup, and beetroot, and dried overnight. Each stained cloth was soaked in 200 ml of 0.1% detergent solution for 10 minutes, followed by rubbing five times with equal force. The cloth was then rinsed with distilled water and air-dried. Cleaning performance was visually compared before and after washing.

**6. Conductivity and EMF Measurements:** Detergent solutions (0.02 g in 100 ml distilled water) were analyzed for conductivity and electromotive force (EMF). Conductivity measurements were performed after heating the solutions to 40 °C and allowing them to cool, ensuring temperature consistency. EMF values were also recorded under identical conditions.

**7. Critical Micelle Concentration (CMC):** The CMC of the detergents was determined by measuring the conductance of solutions at varying concentrations. Conductivity values were plotted against detergent concentration, and the inflection point of the curve was used to identify the CMC. This parameter reflects the concentration at which micelles form spontaneously, influencing detergent effectiveness.

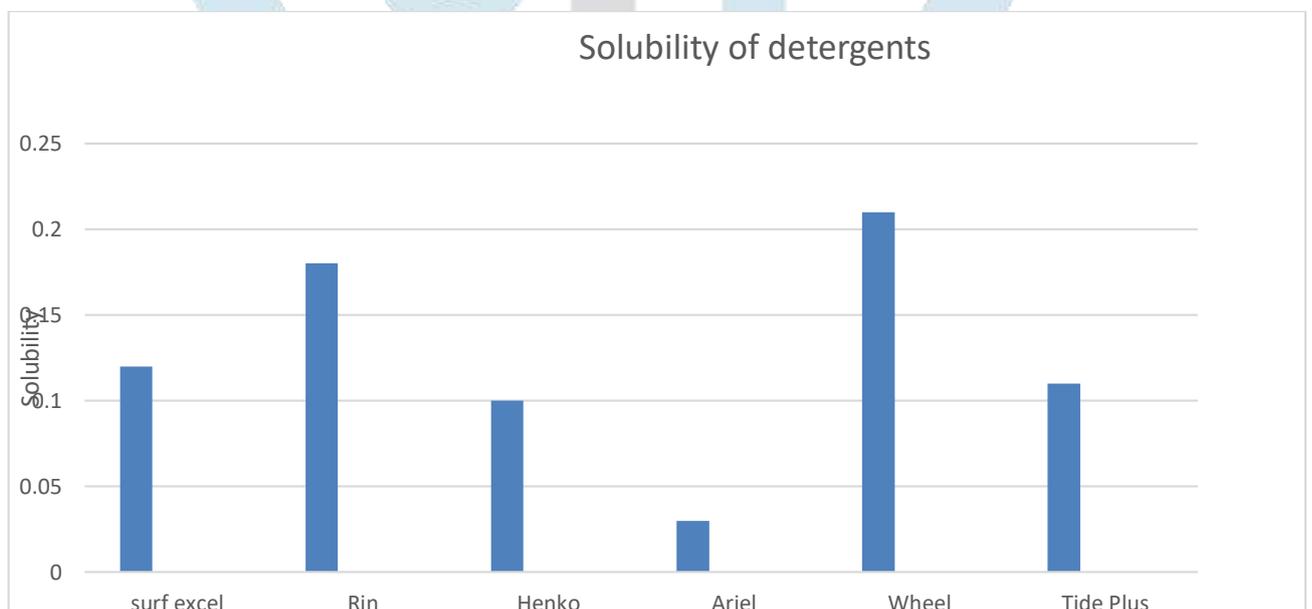
## RESULT AND DISCUSSION:

Comparative study of these detergents which are available in the market is concluded and following are the results:

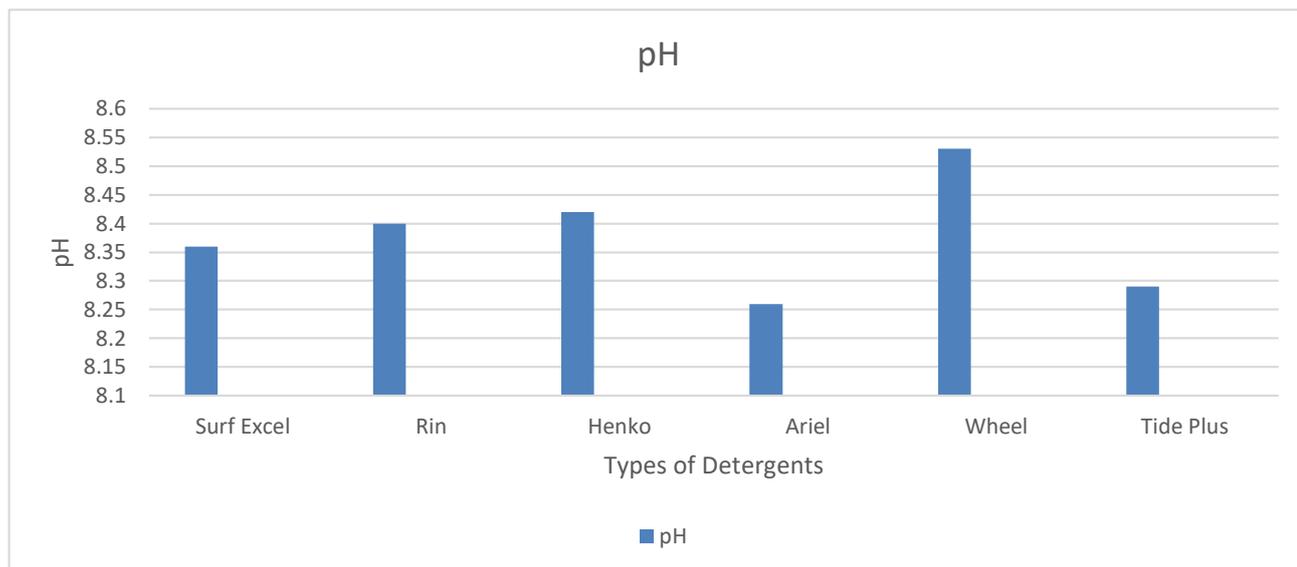
- 1. Solubility Test:** All detergents were highly soluble, though residue content varied. Ariel had the lowest residue (0.03 g), while Wheel showed the highest (0.21 g).

Table 1: **Solubility Test**

Sr.no.	Name of detergents	Weight of Whatmann filter Paper	Weight of Whatmann filter paper with residue	Weight of residue
1	Surf excel	0.74 g	0.86 g	0.12g
2	Rin	0.68 g	0.86 g	0.18g
3	Henko	0.74 g	0.84 g	0.10g
4	Ariel	0.74 g	0.77g	0.03g
5	Wheel	0.70 g	0.91g	0.21g
6	Tide Plus	0.67 g	0.76 g	0.11g

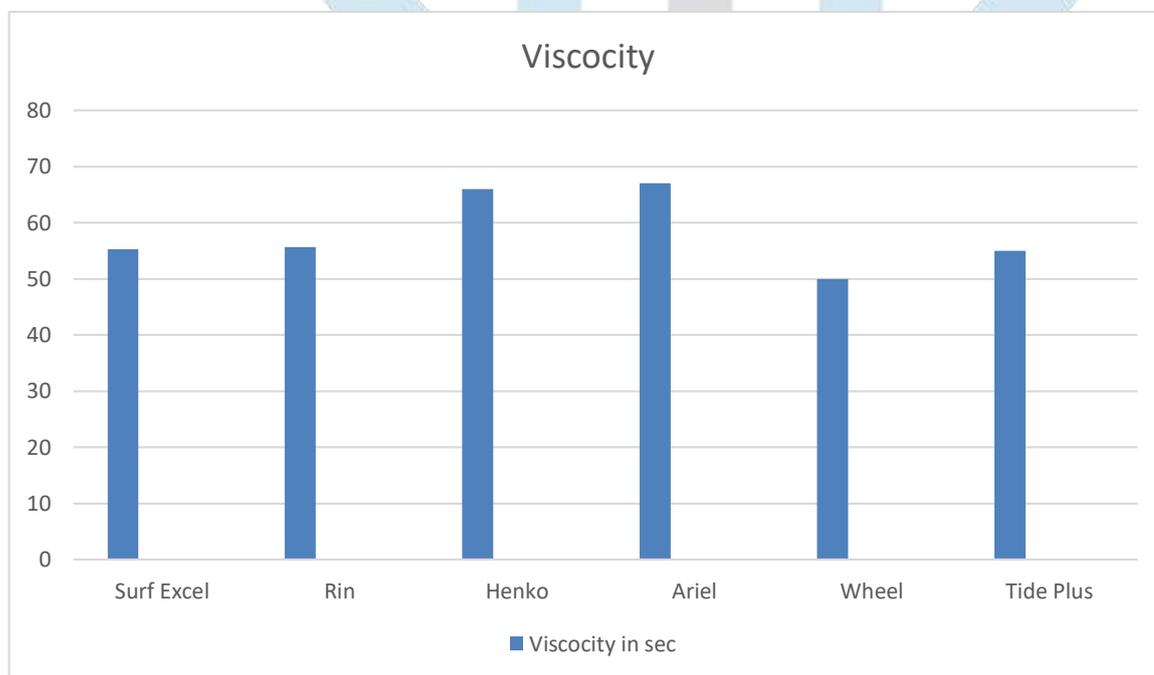
**Fig. 1: Solubility of detergents**

**2. pH:** All detergents were alkaline (pH > 8), confirming their strong cleaning potential but also indicating possible skin irritation risks.



**Fig. 2: pH of detergents**

**3. Surface tension:** Detergent solutions reduced surface tension significantly, enhancing wetting ability and stain removal.



**Fig. 3: Viscosity of detergents**

**4. Foaming Stability:** Foam stability varied. While foam presence influenced consumer perception, cleaning action did not directly correlate with foam quantity.

**5. Cleaning Action:** Surf Excel and Ariel demonstrated the best performance across different stains, particularly against mud and tea.

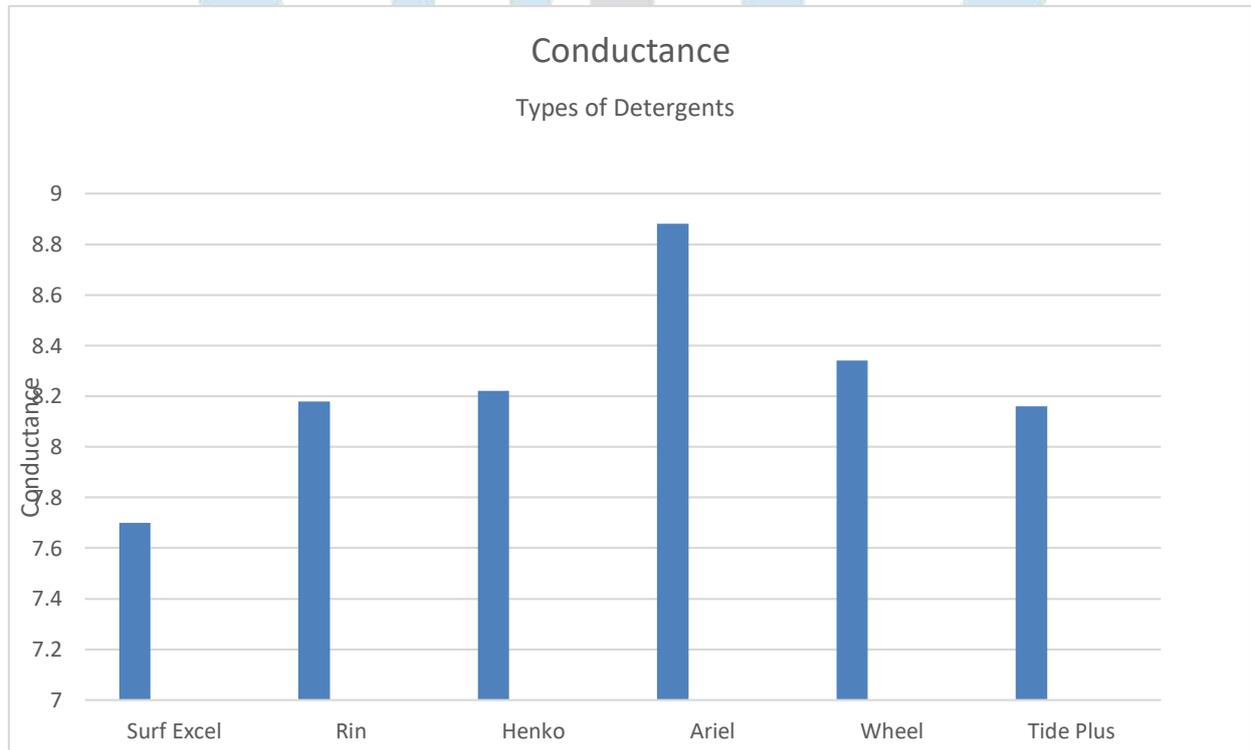
Sr. no.	Sample cloth stained with	Before washing	After washing
1	Beet root		
2	Tea		
3	Ketchup		



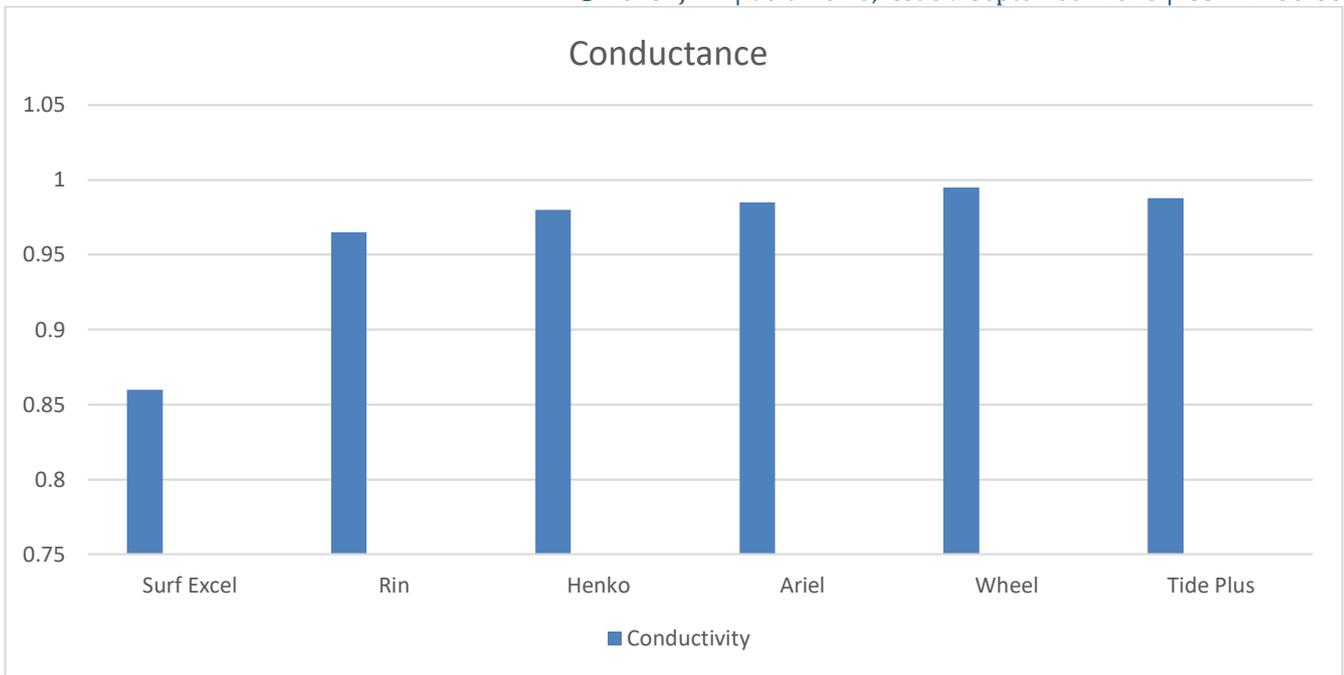
**Fig. 4: Cleaning action of detergents**

**6. Conductivity and EMF:** Firstly the conductance of different types of detergents 0.02 grams in 100 ml of distilled water is been measured and recorded.

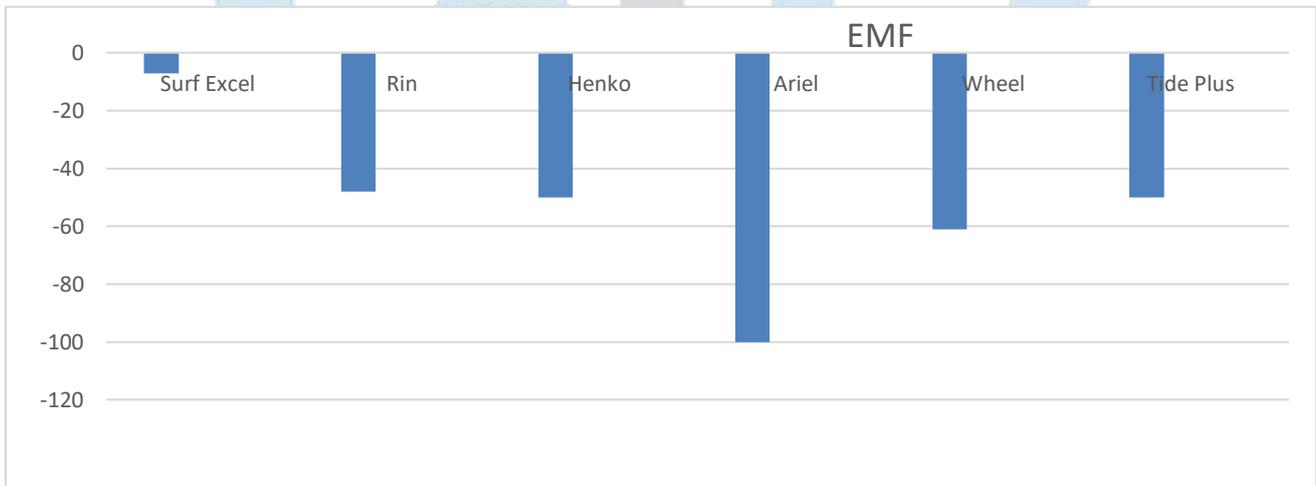
Conductivity increased with concentration, reflecting ionic surfactant activity. Ariel and Tide showed higher values. EMF remained negative for all samples.



**Fig. 5: Conductance of detergents**



**Fig. 5: Conductivity of detergents**



**Fig. 6: emf of detergents**

**7. Critical Micelle Concentration (CMC):** Ariel and Surf Excel had lower CMC values, forming micelles more readily, which contributed to superior cleaning action.

Table 2: Critical Micelle Concentration (CMC)

		conductance observed (mS) for					
sr.no.	concentration (M)	Surf excel	Rin	Henko	Ariel	Wheel	Tide Plus
1	0.02	7.56	7.66	7.75	8.82	8.26	8.57
2	0.01	3.94	3.98	4.25	4.67	4.38	4.57
3	0.008	2.97	2.99	3.03	3.8	3.6	3.81
4	0.006	2.5	2.62	2.44	2.94	2.81	2.98
5	0.004	1.9	1.68	1.75	1.86	1.92	2.12
6	0.002	0.89	0.91	0.92	1.02	1.08	1.06

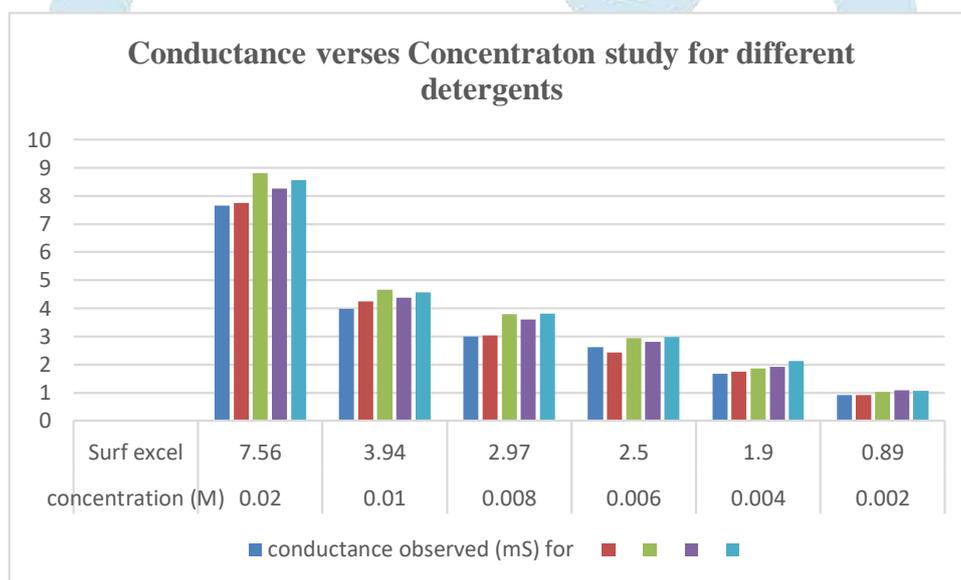


Fig. 6: Conductance versus concentration study of different detergents

Overall, Ariel and Surf Excel consistently outperformed other brands across most parameters.

**CONCLUSION:** The comparative study of six widely used detergent brands demonstrated clear differences in physicochemical properties and cleaning efficiency. While all detergents were alkaline and soluble, Ariel and Surf Excel exhibited superior results in terms of solubility, surface tension reduction, foaming stability, and stain removal. These findings highlight the importance of surfactant composition in detergent performance.

Future research will involve detailed studies of CMC values and the kinetics of micellar reactions, with potential applications in accelerating reaction rates using surfactants, thereby expanding their utility beyond cleaning action.

## REFERENCES

1. Sigma-Aldrich. (n.d.). *Detergent properties*. Retrieved from <https://www.sigmaaldrich.com/IN/en/technical-documents/technical-article/protein-biology/protein-lysis-and-extraction/detergent-properties>
2. U.S. Geological Survey. (n.d.). *Surface tension and water*. Retrieved from <https://www.usgs.gov/special-topics/water-science-school/science/surface-tension-and-water>
3. OpenWetWare. (n.d.). *Critical micelle concentration (CMC)*. Retrieved from [https://openwetware.org/wiki/Critical\\_micelle\\_concentration\\_\(CMC\)](https://openwetware.org/wiki/Critical_micelle_concentration_(CMC))
4. Core.ac.uk. (2012). *Factors affecting micelle formation*. Retrieved from <https://core.ac.uk/download/pdf/33797817.pdf>
5. INFLIBNET. (n.d.). *Factors affecting CMC of micelle*. Retrieved from [http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp\\_content/chemistry/10.physical\\_chemistry-iii/28.factors\\_affecting\\_cmc\\_of\\_micelle/et/5517\\_et\\_et.pdf](http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/10.physical_chemistry-iii/28.factors_affecting_cmc_of_micelle/et/5517_et_et.pdf)