

**Comparing the Biological Capacity and Detergency of Dawn Dish Detergent to Natural  
Brands**

AP Research

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## **Comparing the Biological and Detergency Capacities of Dawn Dish Detergent to Natural Brands**

Whether a family chooses to clean in the kitchen by hand or by using the dishwasher, or even both, depends on a variety of factors, such as culture, costs, and energy efficiency (Berkholz et al., 2010). Manual dishwashing has continued to be a popular method of cleaning, leading to the extensive use of liquid dish soap products. Ever since the mid 20<sup>th</sup> century, dish detergents have been crucial towards keeping kitchenware and dishes clean of grime and grease. However, with the large use of dish detergents came the growing ecological and individual problems derived from its ingredients. Surfactants, the chemical compounds used to break up the surface tension in liquids to remove particulates, end up in wastewater due to dishwashing. Surfactants are difficult to treat in plants, due to the difficulty in separating them from oils and greases they are attached to. Within the environment, they both make it harder for dissolved oxygen to enter bodies of water and allow persistent organic pollutants (POPs), compounds that build up in the body and pose several health effects, to dissolve in them. (S.O. et al., 2021).

Consumers have always been looking for ways to minimize their ecological footprint through purchasing products from environmentally friendly organizations. This brought the concept of “green marketing” for companies to retain a positive image in order to continue selling their brands. However, companies promoting themselves as green may not realistically meet the expectations of consumers, “adopting green marketing in an irresponsible or even unreal fashion” (Andreoli et al., p. 3, 2023). This leads to consumers being “greenwashed”, where they are sold by a false positive image which may not fully meet their expectations.

Dawn dish soap, the most popular dishwashing detergent used in America, is widely known for its contributions towards wildlife, like with its “Dawn Saves Wildlife” program, where they partner with other organizations such as the “International Bird Rescue” to conserve both bird and marine health. However, consumers who see the superficial contributions of Dawn dish soap for the environment may overlook the vast dangers of its artificial compounds. Dawn’s “degreasing properties” enable it to assist in the rescue of sea otters and waterfowl affected by oil spills. However, Dawn also comes with several adverse effects. For instance, when used to decontaminate sea otters, the soap can prevent them from producing the natural oils needed for insulation for several days. Additionally, when used on canines, Dawn dish soap can cause mild to moderate skin irritation. This indicates that while Dawn strives to mitigate its environmental impact through programs that aid wildlife, it still poses risks due to certain harmful compounds in its formulation. (Powell, 2019).

## Literature Review

### Effects of synthetic compounds

Synthetics, materials that aren’t found naturally and instead made through human intervention, have a wide application in industrial production, primarily due to their overall cheap production costs and their several important properties, such as durability (plastics), and flexibility. Nonetheless, their use can contribute to several problems that can quickly become dramatic as they start to spread out into the environment and degrade into gaseous substances such as volatile organic compounds (VOCs), which can form at room temperature. The Environmental Protection Agency (EPA) provides information about the sources and symptoms of VOCs, what concentration levels are considered safe, as well as ways to reduce them within households. According to the EPA, whether in a rural or urban setting, VOCs can be “2 to 5

times higher inside homes than outside” (U.S. EPA, 2021). Although the EPA makes sure that VOC levels outdoors are regulated, they have no authority over the VOC emissions of household products, which means that products like cleaning agents are not directly controlled by any federal VOC standards. Singer’s study examines how particularly reactive cleaning agents lead to unhealthy levels of VOCs and secondary pollutants within a household. He determined the “product use rates” of each subject within the study, and afterwards the concentration of VOCs within a room, concluding that absorbent objects, such as sponges and towels, retain cleaning chemicals for long periods of time leading them to interact with the air longer and cause higher concentrations of VOCs (Singer, 2021). Additionally, as shown through Pacini’s cross-sectional analysis of the National Poison Data System, exposure to household cleaning products is also transparent in the form of consumption, primarily for children. She analyzed trends over 15 years of the number of poison exposures for children specifically from cleaning products. She was able to determine that around 80% of exposure calls were for children under the age of 3, with many of the calls coming from the intake of bleach and alkali compounds (Pacini 2023). The relative number of exposure calls hasn’t changed over time, meaning that for vulnerable demographic age groups, such as toddlers, their high rates of chemical exposure haven’t been reduced for several years. This persistent risk highlights the need for safer alternatives, such as natural brands, which can help lower long-term health hazards from chemical exposure inside households.

### **Attitudes towards biological brands**

Exposures to dangerous compounds from cleaning products can be directly prevented through the use of more natural brands, as explored through Harley’s study from the levels of

exposure after switching from conventional to greener household cleaning products. Her study looks at whether using cleaning products that claim to have less chemicals reduces exposure to dangerous compounds inside a household, indicating that the concentrations of several endocrine-disruptors, toxicants, and carcinogens lowered once households transitioned to the use of green labelled cleaning products. However, she also indicated that it was difficult to transition towards green products for several households because of problems such as costs and availability (Harley, 2021). Within several countries such as India, though, natural dishwashing tools are cheaper, reproducible, and more sustainable, as shown through Kora's journal on cleaning materials used within India. She looked into currently used natural dishwashing tools within India and assessed their overall benefits in comparison to artificial surfactants. For several years, Indians would use "plant saponin biosurfactants", natural compounds derived from plants that have similar properties to synthetic surfactants, to meet their daily hygienic needs. Acidic produce, leaf greens, saponins, and natural deodorizers are all used by several households for dishwashing, whether to reduce odors or to remove grease and bacteria (Kora, 2024).

The positive image of sustainability has also been growing rapidly, as shown by Yao's study on household preferences when choosing liquid dish soaps. He examined the purchasing preferences of 385 New Zealand households for liquid soap through a choice experiment, aiming to identify factors influencing consumer decisions, estimate their willingness to pay for specific product attributes, and evaluate awareness of contaminants such as triclosan. His results indicated that respondents were willing to pay more for soap with environmental certification, hypoallergenic properties, natural ingredients, and antibacterial claims (Yao, 2019). Natural brands can be both practical and effective when integrated thoughtfully into everyday use, making the case stronger for shifting consumer habits toward biological dish soaps. And, seeing

the global support for greener practices, making the switch would ultimately no longer be a difficult transition.

### **Advantages of natural dish detergents**

While natural brands may not contain important cleaning chemicals found in many other soaps, such as triclosan, an antibacterial agent, or sodium lauryl sulfate (SLS), a surfactant, they have plant-based alternatives that are able to give similar results. Phytochemicals, produced through plant metabolism, are generally inexpensive and environmentally safe. Gomes's study compared the effectiveness of 3 phytochemical-based biocides, which were cheap and environmentally friendly, to synthetic biocides against inhibiting the growth of bacterial strains. He initially discussed problems such as bacteria growing resistance to cleaning agents overtime and the need for new types of "disinfectant solutions". What he found out was that the plant-based biocides either were able to perform on par or better compared to synthetic biocides, most likely to the initial resistance the bacteria had to the tested compounds (Gomes, 2016). Cruz's study also provides another solution towards multidrug-resistant microorganisms: essential oils. He discusses the antimicrobial properties of essential oils, particularly clove, oregano, and thyme oils, and their potential as alternatives to conventional antiseptic agents like chlorhexidine and triclosan and evaluated the antibacterial and antifungal activities of these essential oils against various strains, including multidrug-resistant bacteria and fungi. His results showed that the essential oils exhibit potent inhibitory effects, with clove, oregano, and thyme oils demonstrating the most promising antimicrobial activity (Cruz, 2024). As essential oils are produced as defense mechanisms by plants against pathogens, they can naturally adapt to microorganisms even as they mutate over time. As bacteria starts to become more resistant to surface cleaners, it is important that the resources used, especially for green cleaning products, remain as efficient as synthetic cleaners so that consumers are encouraged to use it as a healthier alternative.

Additionally, biosurfactants are able to be compared to synthetic surfactants. From Fink's study, saponins, metabolites that are formed by plants as a defense mechanism, exhibit the same foaming properties as sodium lauryl sulfate. It indicated that a specific organic substance, quillaja saponin, was able to perform more effectively than another tested synthetic cleaner, sodium dodecyl sulphate (SDS), both in clumping up bacteria/particles and breaking down oil (Fink, 2023). Furthermore, quillaja saponin was significantly less toxic than SDS, requiring 200 times the dosage to cause any significant damage to the human body.

Within our industrializing society, biological dish soaps will also be important to reduce sources of atmospheric and environmental pollution. Farias's study takes a deeper look into the use of green surfactants. It discusses the importance of green cleaning products, primarily cleaning products, towards sustainability and limiting pollution. Creating cleaning products that either use "industrial waste products or sustainably produced substrate" will enable pollution to be controlled in the long term (Farias, 2021). Even though producing biosurfactants can be costly, its low environmental impact helps displace this cost, and cheaper sources of biological products are being found every year. Green surfactants are produced directly from parts of a plant, "such as the roots, stems, seeds, fruit, and leaves", which contain hydrophobic and hydrophilic features necessary for all detergents. By using a reproducible material as an alternative and renewable source for cleaning products, biosurfactants implement necessary features required to clean while being more beneficial than artificial cleaners. In her paper, Kora has also asserted that the initiatives which India is taking to shift towards "sustainability" and a more "circular economy" also follows the United Nation's "Sustainable Development Goals", reflecting a commitment to address pressing environmental and health challenges. Bringing these endeavors into other countries would produce a significant impact on how long we are able to sustain our limited resources.

Natural cleaning compounds, like phytochemicals, essential oils, and biosurfactants, have proven to be as effective—if not more effective—than synthetic agents in combating bacteria and breaking down grime. They offer a sustainable pathway for maintaining hygiene without the escalating problems of resistance and pollution caused by chemical detergents.

## **Gap in Literature**

Dish detergents have been well researched on all sides, from their ingredients, capabilities, and environmental safety. However, decisive tests have yet to be taken to answer the question towards why commercial brands, specifically Dawn dish soap, is being used over greener products on the premise of effectiveness. While this paper had showcased the problems associated with Dawn dish soap and other synthetic agents, the purpose of this study is to compare Dawn to alternative, natural dish detergents and see whether natural brands can outperform that of Dawn on the premise of two tests: a Kirby-Bauer disc diffusion test, and a saturation analysis which will evaluate the detergency as well as antibacterial effectiveness of each soap. Ultimately, this standardized approach is able to give insight towards the broader significance of using natural detergents as sustainable alternatives.

## **Method**

### **Antibacterial Test**

To determine antibacterial effectiveness, I will be performing a Kirby-Bauer Test, measuring the inhibition zone diameters, which is the area of inhibited growth around a solution, for a few dish soap brands, replicating the study of Dai et al. (2009). The Dawn dish soap brands I used for my experiment are ‘Dawn Ultra’ and ‘Dawn Antibacterial – Apple Blossom’ dish soap, due to being relatively common types of Dawn products. The three natural brands of dish soap they will be compared to is ‘Koala Eco’, which contain essential oils made up of lemon myrtle,

‘Puracy’, which contains plant-based enzymes, and ‘PureCastile’, which only relies on a variety of plant-based oils which are found in most plant-based dish detergents. Essential oils, which, as explained by Cruz et al. (2024), have antibacterial properties against various strains, including multi-drug resistant bacteria, so testing it will enable me to see how significantly it impacts the antibiotic effectiveness of natural dish detergents. Plant-based enzymes are able to act as catalysts which are able to improve the rate of breaking down fats and soil (Naganathan 2017), so using ‘Puracy’ will additionally allow me to make further conclusions.

The supplies I will be using are the dish detergents, forceps, cotton swabs, 0.25 in. antimicrobial discs, and nutrient agar plates. First, I will use a cotton swab and take a sample of natural bacteria from my kitchen counter, and uniformly streak the entire surface using a sterile cotton swab, ensuring even bacterial distribution. The antibiotic sensitivity discs will each be impregnated with a solution of undiluted dish detergent, by using sterile forceps to fully submerge and saturate them in a sample of solution and then allowing each of them to dry at room temperature inside a sealed bag for 1 hour. The discs are then again picked up with forceps and then gently pressed atop the agar. For each of 4 agar plates, I will put 4 antibacterial discs, each containing either a sample of ‘Puracy’, ‘Koala Eco’, ‘Dr Bronner Castile’ (mentioned as ‘Pure Castile’), and ‘Dawn Ultra’ dish soap. A separate agar plate with 4 samples of ‘Dawn Antibacterial – Apple Blossom’ will be used as well, in order to ensure that the IZDs of the saturated discs do not overlap with each other. Each of the agar plates are then closed and thoroughly sealed with tape to prevent contamination from the outside environment. I then put them inside the oven at 37 degrees Celsius for approximately 24 hours, in order to produce an ideal environment for the bacterial cultures and give them enough time to cultivate. The plates were then taken out. Using a ruler or digital caliper, I measured the width of the inhibition zone around each disc at multiple angles and calculated the average width for each disc. I then

averaged the values from all four discs of the same soap brand to determine the overall width inhibition zone for that brand. Evaluating the inhibition size from each brand will determine their antibiotic potential. Since the Kirby-Bauer test is a qualitative assay, it isn't necessary to perform a statistical test to determine the statistical significance between brands. However, this would be plausible if a larger sample sized was used ( $n > 15$ ) such that a statistical test would be reliable. Instead, conclusions will solely be based on the average relative sizes of the inhibition zones.

### Detergency Test

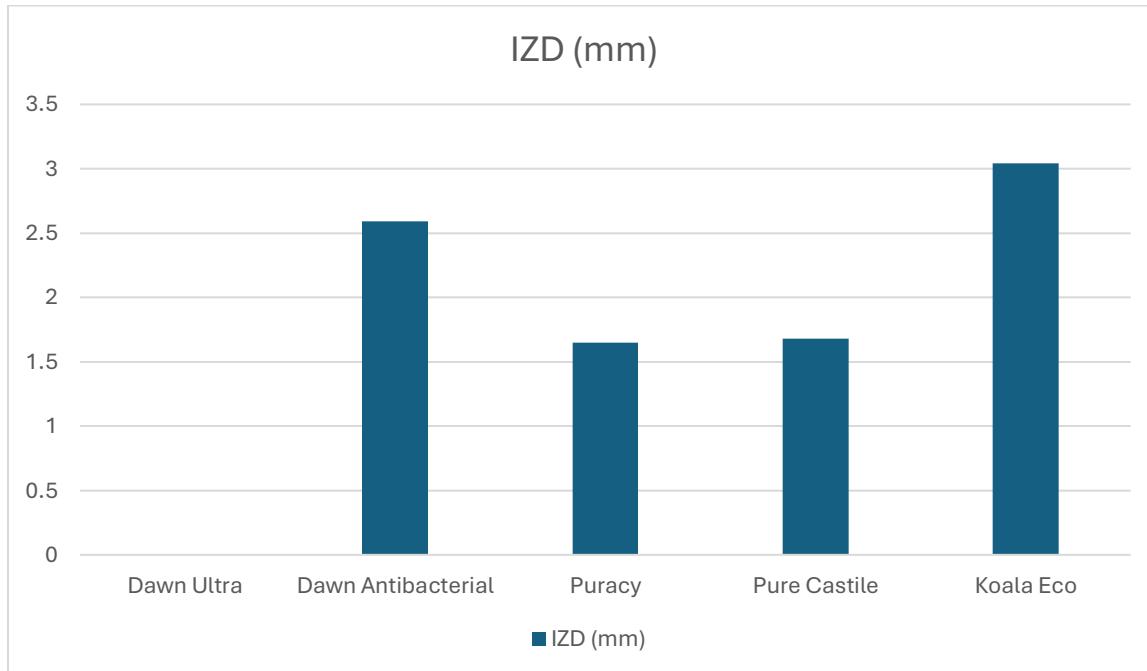
I will also perform another test to evaluate the detergency of the dish soaps I used through a relationship between dish soap concentration and oil removal. For the second half of the study, 'Great Value' vegetable oil will be used, as well as 2.5x2.5 in. white cotton fabric swatches, to test how effective each of the dish detergents are in removing oil. All the dish soaps used in the previous test, with the exception of 'Dawn Antibacterial', will be used, as it has essentially the same formulation as 'Dawn Ultra' with the exception of the biocides it contains, making it only relevant to the previous test I did. Cotton will be used because it is highly absorbent, meaning that the swatches will have a measurable change in mass, making it easier to determine the percent reduction after treating oil-soaked swatches in dish soap solutions. This is similar to the method used by Miller et al. (2008) in which different surfactants were used to determine a trend between the dilution of a solution and its overall performance to create a saturation curve, in which the 'plateau' of the curve was used to establish its effectiveness.

The primary equipment includes the 21 fabric swatches, an electronic scale, newspaper, vegetable oil, forceps, plastic cups each containing a different dish soap solution, as well as a bowl which will be filled with tap water. 'Dawn Antibacterial' isn't used in this part of the study as the only difference in its formulation compared to 'Dawn Ultra' is primarily its biocide

component. First, each of the fabric swatches' mass were individually recorded using the electronic scale, up to two decimal places. All the fabric swatches were later fully submerged into vegetable oil, and then allowed to dry on newspaper so that any excess oil is removed from the fabric swatches. After they were dried, the amount of oil inside each of the swatches was found by subtracting the mass of the oil-soaked swatches by their initial masses. After one day passed, I measured the mass of the fabric swatches again. For each of the 20 oil-soaked fabric swatches, they will undergo a treatment of either four of the dish soaps used, which will each be diluted to 5 different concentrations: 50%, 25%, 12.5%, 6.25%, and 3.125%. The dish soap solutions are created by initially adding 120 mL of the dish detergents into a cup and mixing it with 120 mL of tap water, pouring half of the solution into another cup, then repeating this until 5 serially diluted solutions are made. For each of the 4 dish soaps tested, 5 fabric swatches will be used, 1 for each diluted solution, which was initially rinsed for 20 seconds in a dish soap solution, and then rinsed in a bowl filled with room temperature tap water for 15 seconds. The cleaning process was done through picking up each swatch with forceps and then stirring them in both the dish soap solution and then the tap water. One fabric swatch was also used as a control variable, and was only rinsed with tap water for 20 seconds. It's important that the rinsing process used is consistent for each of the fabric swatches. Afterwards, the swatches were left to dry on a non-absorbent surface for 2 days to ensure that any water present in the swatches had fully evaporated. The amount of oil still present in the fabric swatch was then found by subtracting the mass of the swatch after treatment by its initial mass. While Miller et al.'s study found a relationship between concentration and substrate removal, they instead measured soil removal instead of oil removal as their independent variable within their study.

## Results

After performing the Kirby-Bauer test, I was able to identify trends between each of the brands as shown in Appendix A, leading to the graph below:



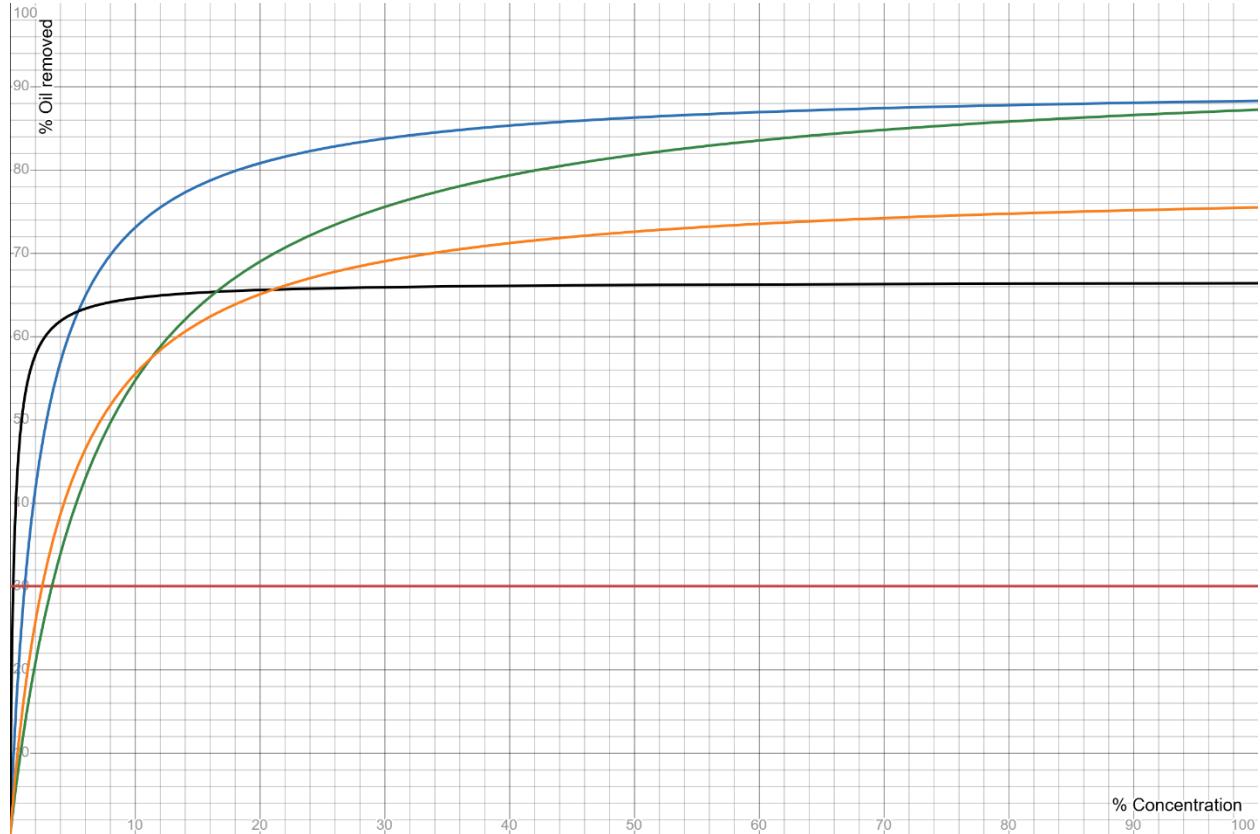
The data showed a clear difference between the purposes of 'Dawn Ultra' and 'Dawn Antibacterial'. The purpose of 'Dawn Ultra', rather than killing off bacteria, has a composition primarily suited towards foaming and grease removal, meaning it doesn't contain any biocides. Since triclosan, one of the more popular biocides, has been banned by the FDA in several products, chloroxylenol has instead been incorporated within their Antibacterial dish soap. However, chloroxylenol, although less toxic to humans, is still highly toxic towards the environment and acts as an endocrine disruptor.

All three tested natural brands have an IZD that is greater than 0, even though 'Puracy' nor 'Pure Castile' contain essential oils, meaning that plant-based brands naturally have

biological-resistant ingredients inside them. However, the product with essential oils had a significantly larger IZD, nearly twice as greater than the two brands that didn't use any. Looking at the inhibition zones around the discs, however (Appendix B), the inhibition zone around 'Koala Eco' was relatively murky, which could possibly be because: the potency of the soap becomes less effective over time while in the agar plate, leading to bacteria growing within the inhibition zone, or that there were some species of bacteria from the sample that aren't able to be removed by the dish soap. Similar conclusions could also be seen with 'Dawn Antibacterial', however the inhibition zones for 'Koala Eco' were noticeably bigger.

The saturation curves for the detergency test were plotted using a Desmos graph. The red horizontal line is the baseline indicator for when only water was used to clean the soiled swatches. All values used to plot the saturation curves can be found in Appendix C.

### Detergency of Dish Soap Brands across Various Concentrations



*Black – Dawn Ultra; Blue – Koala Eco; Green – Puracy; Orange – Pure Castile*

The intersection between the saturation curves and the baseline indicates the minimum concentration of the dish soap to effectively remove oil, while the slope represents the efficiency. The plateau represents the approximate value at which the % oil removed peaks.

The approximate plateau values are:

- Dawn Ultra (Black): ~65% oil removal
- Pure Castile (Orange): ~70% oil removal
- Puracy (Green): ~85% oil removal
- Koala Eco (Blue): ~88% oil removal (highest overall)

All the saturation curves shown had significant variation in plateaus, which may be explained by a sample size of 5 for each brand and the lack of multiple trials. Dawn dish soap had the smallest effective concentration of around 0.25%, as well as the largest efficiency, compared to the natural brands. In contrast, the other brands ('Koala Eco Puracy', and 'Pure Castile') require around 1-2% concentration before they start showing notable oil removal. However, at large concentrations all the natural brands of dish soap were able to remove a larger % of oil from the fabric swatches than 'Dawn Ultra' dish soap.

However, it's also important to realize that even after rinsing off the dish detergents with water, there may have still been surfactant still present on the cotton swab. This may especially be true for when testing large concentrations of each dish soap, coupled with the relatively short rinse time of around 15 seconds. From this fact it's important to realize that the small effective concentration of 'Dawn Ultra' dish soap could possibly come from it leaving behind more residue than the natural brands, potentially skewing results at higher concentrations. Future experiments could control for this variable by implementing a standardized rinsing method, such as increasing rinse time or using an additional solvent to remove excess surfactant.

## Discussion

The inhibition zone diameters (IZD) observed in natural dish soaps provide further evidence that plant-based brands inherently contain biologically resistant compounds, even in the absence of essential oils. This finding suggests that natural detergents may retain antimicrobial effectiveness through intrinsic phytochemicals, supporting Gomes's (2016) conclusions on the efficacy of plant-based biocides against bacterial strains. Notably, the soap containing essential oils exhibited an inhibition zone nearly twice as large as the other natural brands, reinforcing Cruz's (2024) assertion that essential oils such as clove and oregano have strong antibacterial

properties. However, the inhibition zone observed in ‘Koala Eco’ suggests a potential unreliable of the potency of some essential oils, raising questions about the stability of them in cleaning applications.

These findings further support the transition toward biosurfactants and plant-derived antimicrobials as viable alternatives to synthetic cleaning agents. As Fink (2023) demonstrated with quillaja saponin’s superior foaming and oil-removal capabilities compared to synthetic surfactants, the natural inhibition of bacterial growth observed in plant-based brands underscores the broader potential of biosurfactants. ‘Koala Eco’ was made with greens including orange, lemon, and coconut, which reveals how easy it is to create a solution to clean without the use of petrochemicals found in many store brands. Given the environmental persistence and potential health risks associated with synthetic biocides, integrating plant-derived antimicrobials into cleaning products offers a promising solution for balancing efficacy with sustainability.

On the basis of detergency, however, it’s hard to fully decide whether Dawn overperformed or underperformed every other detergent. On the other hand, ‘Koala Eco’, the brand with essential oils, completely did better on the premise of a lower baseline concentration, higher efficiency, and the largest maximum % oil removed compared to the other two natural brands. This could be explained by the additional degreasing properties of the citral essential oil over the milder surfactants used by both ‘Puracy’ and ‘Pure Castile’. Determining whether or not to use Dawn as a dish detergent, however, should take into consideration costs, cleaning time, and cleaning methods, considering the high efficiency of Dawn dish soap.

## **Limitations**

Several sources of error were present in both the Kirby-Bauer test as well as the detergency test. For instance, not coating the agar with a specific species but instead using a

sample from a kitchen counter would lead to the inhibition zones to be inconsistent, as having multiple species, each with varying sensitivities, would cause irregular inhibition zones as saw through the murky regions for both ‘Dawn Antibacterial’ and for ‘Koala Eco’. Using a standardized reference strain, such as E. Coli, would provide a better baseline for comparison between each of the brands. Additionally, some of the agar plates weren’t streaked well enough, leaving patchy or uneven bacterial lawn, which also contributed to the difficulty in measuring each zone. If this study was instead done in a laboratory, more controlled conditions could be maintained, reducing variability and improving accuracy. In a laboratory setting, factors such as temperature, humidity, and incubation time would be standardized, ensuring consistent bacterial growth and antibiotic diffusion.

For the detergency test, although saturation curves were able to be made comparing the concentration of dish detergent to the amount of oil removed, there was still huge variability as inconsistencies in sample preparation and external factors affected the results. Future experiments comparing Dawn, if the necessary equipment is available, should incorporate more controlled methods to minimize variability. Differences in how oil was applied and rinse time led to uneven oil removal. Additionally, variations in detergent mixing may have resulted in inconsistent concentrations. Unlike surface tension tests, which rely on more quantifiable and controlled methods (such as the drop count or capillary rise), the detergency test involves more variables that are harder to control. Surface tension tests typically produce less variability because they focus on a single physical property (the ability of soap to disrupt molecular cohesion) rather than the complex interaction of soap with oil and surfaces. Furthermore, in foam stability tests (measuring how long soap bubbles last) or emulsification tests (how well soap mixes oil and water), variability is often reduced by using controlled environments with

standardized sample sizes and automated measurements. In contrast, the detergency test's reliance on manual processes makes it more prone to error.

## Conclusion

Due to the lack of laboratory experience, inadequate equipment, and inconsistent methods, it's hard to produce a definitive conclusion that fully justifies using natural alternatives over Dawn dish soap, especially as my method didn't account for demographic opinions, only a select few dish soap brands, costs, and whether natural brands themselves have any issues as well. This study took a very narrow approach in order to support the use of natural brands, however ultimately it nonetheless is able to suggest that further research into the complex makeup of different kinds of plants will be beneficial for their development. Seeing how it was already difficult to find popular green products on the market for my study, it's reasonable to assume that there is a lack of research within this field. Researchers can continue to find breakthroughs in plant-based ingredients, either to further improve surfactant action or the disinfecting properties of dish soap. As there are hundreds of thousands of species of plants out in the world, that means that there are just as many possibilities to continue to develop better formulations.

## Appendix A

Petri Dishes	Dawn Ultra	Puracy	Pure Castile	Koala Eco
#1	0 mm	1.25 mm	1.25 mm	2.25 mm
#2	0 mm	1.30 mm	2.35 mm	4.15 mm
#3	0 mm	1.90 mm	1.10 mm	3.35 mm
#4	0 mm	2.15 mm	2.00 mm	2.40 mm
Average	0 mm	1.65 mm	1.68 mm	3.04 mm

Disc #1	2.40 mm
Disc #2	2.30 mm
Disc #3	2.40 mm
Disc #4	3.25 mm
Average	2.59 mm

### Appendix B



Right - Pure castile	Right - Puracy	Right - Pure	Right - Puracy
Top - Koala Eco	Top - Koala Eco	castile	Top - Koala Eco
Left - Dawn Ultra	Left - Pure Castile	Top - Koala Eco	Left - Dawn Ultra
Bottom - Puracy	Bottom - Dawn Ultra	Left - Dawn Ultra	Bottom - Pure
		Bottom - Puracy	Castile



Dawn  
Antibacterial

### Appendix C

Brand	Concentration	Initial mass of swatch	Mass of swatch with oil	Mass after swatch was cleaned	% of oil removed
Koala Eco	50%	0.68	1	0.68	100
	25%	0.62	0.97	0.75	62.85714286
	12.5%	0.67	1	0.75	75.75757576
	6.25%	0.67	1.04	0.76	75.67567568
	3.125%	0.66	1	0.84	47.05882353
Dawn	50%	0.65	1	0.76	68.57142857
	25%	0.65	1	0.77	65.71428571
	12.5%	0.67	1	0.79	63.63636364
	6.25%	0.67	1	0.8	60.60606061
	3.125%	0.69	1.09	0.84	62.5

Puracy	50%	0.66	1	0.74	76.47058824
	25%	0.68	1.09	0.79	73.17073171
	12.5%	0.66	0.98	0.75	71.875
	6.25%	0.69	1.07	0.91	42.10526316
	3.125%	0.64	1	0.93	19.44444444
Pure Castile	50%	0.65	1.03	0.76	71.05263158
	25%	0.66	0.98	0.77	65.625
	12.5%	0.68	1	0.81	59.375
	6.25%	0.66	1	0.8	58.82352941
	3.125%	0.66	0.92	0.86	23.07692308

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