# Effects of Foam Hand Soap on Water Consumed During Typical Hand Washing

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## ABSTRACT

Foam format soap was tested against liquid soap to determine if water consumption during hand washing was influenced by the format of the soap alone, and about their perceptions on manually actuated and touch-free soap dispensers. One hundred (100) participants were asked to wash their hands using both foam and liquid soaps, and then were asked to complete questionnaires.

The study showed:

- 9.7% less water was used washing hands with foam soap versus liquid soap with a confidence level of 97%.
- Majority of consumers surveyed perceived the foam soap format to rinse more quickly than the liquid soap.
- 88% of consumers perceived touch-free dispensers as being more sanitary, and 51% perceived touch-free to be more convenient than other types of soap dispensers.
- 61% of consumers said they are more likely to wash their hands in public lavatories with a touch free dispenser

Using foam soap in a touch-free soap dispenser can reduce water consumption, promote better hand hygiene, and improve the perception of the lavatory as being more convenient and sanitary.

## INTRODUCTION

Water scarcity is defined by the Global Water Forum as the lack of sufficient available water resources to meet the demands of water usage within a region.[1]

Water scarcity results from two basic underlying causes; 1) growth in demand for water outpacing infrastructure capacity and 2) physical scarcity of water due to drought or changing climate conditions. Both of these pressures on water supply are increasing in the United States. A World Resources Institute study concluded that world water withdrawals from surface waters has increased nearly twice as fast as global population growth.[2] The USGS published a report in 2013 indicating that from 1900 to 2008, US ground water depletion has increased due to growth in water demand outpacing the capacity for natural replenishment, with a 25% increase in the rate of ground water depletion occurring between 2001 and 2008.[3] As of August 5th, 2014 NOAA's US Drought Monitor indicated that 34% of the 48 continuous United States were in Moderate or worse drought conditions, and 10% is in extreme or worse drought conditions, with impacts primarily in the southwest and western US.[4] At the same time 58% of the state of California was experiencing exceptional drought (see figure 1 in Appendix), the harshest rating on the NOAA scale, with many areas in the state short by more than one year's worth of rainfall.[5] This has prompted the California State Legislature to enact emergency regulations in July 2014 that impose fines of up to $500 per day for citizens and institutions found not following the water conservation regulations.[6]

The long term trend is for water scarcity pressures to increase. A study by UNEP and the World Resources Institute projected 43% of the world's populations will live in water scarce regions by 2025.[7]

As a result of these trends, water is becoming one of the primary sustainability challenges of the 21st century, and pressures from water scarcity are increasingly having an impact to businesses. A 2011 EIRIS analysis showed that 54% of companies are exposed to water risk at some level, and 9.7% have begun monitoring and set goals for water use reductions.[8] The USEPA published a study in 2009 that indicated the commercial sector was consuming 17% of the total water distributed in the US, second only to domestic users. The USEPA same report indicated largest source of water consumption in the commercial sector is the restroom at 37% of total (see figure 2 in Appendix).[9]

The growing green building movement has influenced commercial water users to begin to track their water use and find ways to reduce water consumption to meet these growing trends. In 2009 the United States Green Building Council (USGBC) released LEED version 3 to incorporate ASME A112.18.1/CSA B125.1 into the green building standard that requires a maximum flow rate for a public lavatory of 0.5 gallons per minute.[10] The number of LEED certified buildings has increased dramatically in recent years, going from 12 projects when LEED launched in 2000 to 59,211 LEED certified commercial properties in 2013.[11] The long term trend in green building is for future growth. McGraw Hill's 2013 Dodge Construction Outlook Report shows value of green building has grown from $10 billion in 2005 to $78 billion in 2011, and is projected to reach between $204 billion and $248 billion by 2016, which would represent 55% of all commercial and institutional construction.[12]

Although the lavatory in a public restroom is a significant source of water consumption in the commercial sector, hand hygiene remains an important public health activity, and for good reason. Many independent studies have been conducted showing the importance of hand hygiene on reducing the risks of infectious diseases. One such study published in the Journal of Public Health by A. Aiello, (2008) looked at meta data from 1960 to 2007 and concluded that improvements in hand hygiene reduced instances of gastrointestinal illness by 31% and respiratory illness by 21%.[13] So while it is becoming increasingly important to reduce water consumption, it is equally important to continue to encourage healthy hand hygiene habits.

It has been anecdotally reported for some time that hand wash dispensed in a foam format reduced water consumption and encouraged hand washing by making the experience pleasant and less time consuming. The objective of this study is to test the hypothesis that foam hand wash results in reduced water consumption compared to lotion soap under the same conditions, and to understand the consumer's perception of foam soap and the touch free soap dispensers.

## METHOD

### *Participants*

A centrally located testing facility in West Dundee, IL was used to recruit 100 typical consumers to participate in the hand washing test. Quotas were established for recruiting a range of customers aged 18-64 with half male and half female participants. Consumers were screened out who work in a profession that routinely required hand washing protocols, like healthcare, food service, school workers, etc. All participants were screened to use hand soap when washing their hands, and did not have any known allergies to hand wash products.

### *Experiment Design and Measures*

Two portable "sani sinks" portable hand wash stations were positioned side-by-side in the testing area (see figure 3 in Appendix). The portable hand wash stations enable hot and cold water dispensing that approximate water pressure, temperature, and flow that would be typical in a commercial public lavatory. All water used during hand wash was collected in a container underneath the sink, hidden from view of the participants. After each hand wash event, the water was transferred to a volume calibrated collection chamber.

A touch-free soap dispenser that was capable of dispensing either foam or liquid soap was wall mounted above each sink. The soap dispensers output 0.75 mL of soap regardless of foam or liquid format. The dispensers were identical so the participants had not way of knowing which format of soap was dispensed before the hand washing test. The soap products had similar color and scent, such that the only difference was the format of the soap as dispensed.

The critical analysis was a test of significant differences between the volume of water used by each of the study participants (dependent, 2-tail, t-test).

### *Experimental Procedure*

After being screened, consumers were recruited to participate in a 10-minute study on hand washing in which they were asked to wash their hands twice, once with each format of soap (participants were not provided any information about the soap in the dispensers). Half of the users used liquid soap first, and the other half used foam soap for the first wash. Upon entering the testing center, respondents were placed in front of one of the two identical hand wash stations and asked to wash their hands as they normally would with the soap provided. No direction was given to the participants as to washing protocol or technique. After drying their hands from the first wash, the participants were asked to move to the other hand wash station and repeat the same test with the other soap. The participants were not aware of what was being tested or measured. There was no questioning of the participants during the two wash exercises so as not to call attention to any part of the washing process.

A critical measure after the test respondents left the room was for a facility team member to measure in a calibrated container and record the water collected in each sink. Half way through the testing, the soap dispensers were exchanged such that the test station previously dispensing foam would dispense liquid soap, preventing bias based on location in the testing area.

After completion of the hand washing exercise, each participant was given a questionnaire to complete. The interviewers also recorded whether and how many times each respondent applied water to their hands prior to dispensing the soap. Additional profile questions were asked of the participants after completion of the washing exercises.

## RESULTS

The study showed that 10% less water was consumed when participants used the foam soap format compared to the liquid format. This is statistically significant at a 97% confidence level. In a ratio of nearly 2-to-1, there were significantly more participants who individually used less water washing with foam soap than with liquid soap. This was also evident in the questionnaire results as a majority of respondents indicated they believed they washed their hands faster with foam soap versus liquid soap.

Complete data tables of the results are included in the appendix. The screened participants were ethnically, socio-economically, and culturally diverse as indicated in the sample description data tables in the appendix. Table 1 summarizes the water reductions.

Table 1: Summary of water consumption comparing foam to liquid soap

| Water Used with Liquid Soap | Water Used with Foam Soap |
|---|---|
| 19.6 Mean ounces | 17.7 Mean ounces |
| 31% of respondents used less water with liquid soap | 59% of respondents used less water with foam soap |

Table 2 shows the statistical analysis of the water reduction data. Using a conservative, 2-tail test, there is 97% confidence that 10% less water was used by panelist when washing with foam soap compared to liquid soap.

Table 2: Statistical Analysis Of Water Consumption Measurementsfoam to liquid soap

| | Liquid Soap | Foam Soap |
|---|---|---|
| Mean water use per wash (ounces) | 19.6 | 17.7 |
| Observations | 100 | 100 |
| t Stat | 2.26 | |
| P(T<=t) two-tail | 0.03 | |
| Confidence level | 97% | |

Table 3 shows the detailed results of water consumption collected compared to the format of the soap, gender, age, and other select demographic data of the participants.

| Table 3: difference in water consumption by soap format in total and by key demographic | | GENDER | | AGE | | WASHING FREQUENCY | | PREFER | |
|---|---|---|---|---|---|---|---|---|---|
| | TOTAL | MALE | FEMALE | 18-39 | 40-64 | HIGH | LOW | FOAM SOAP | LIQUID SOAP |
| | (A) | (B) | (C) | (D) | (E) | (F) | (G) | (L) | (M) |
| TOTAL RESPONDENTS | 100 | 50 | 50 | 54 | 46 | 51 | 49 | 43 | 44 |
| | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |
| MEAN: LIQUID SOAP | 19.59 | 19.22 | 19.96 | 18.83 | 20.48 | 20.73 | 18.41 | 19.91 | 20.30 |
| | | | | | | | | | |
| MEAN: FOAM SOAP | 17.70 | 18.06 | 17.34 | 17.41 | 18.04 | 17.94 | 17.45 | 18.16 | 17.93 |
| | | | | | | | | | |
| USED LESS WATER | 31 | 18 | 13 | 19 | 12 | 14 | 17 | 14 | 11 |
| | 31.0% | 36.0% | 26.0% | 35.2% | 26.1% | 27.5% | 34.7% | 32.6% | 25.0% |
| USED LESS WATER | 59 | 28 | 31 | 27 | 32 | 32 | 27 | 29 | 24 |
| | 59.0% | 56.0% | 62.0% | 50.0% | 69.6% | 62.7% | 55.1% | 67.4% | 54.5% |
| | | | | | D | | | | |
| USED SAME AMOUNT | 10 | 4 | 6 | 8 | 2 | 5 | 5 | | 9 |
| | 10.0% | 8.0% | 12.0% | 14.8% | 4.3% | 9.8% | 10.2% | | 20.5% |
| | | | | | | | | | L |

Table 4 are selected results from the questionnaire regarding perceptions of foam soap and touch free dispensers. The full results of the questionnaire are listed in the index.

| Table 4: Select Results From Participant Survey | | | |
|---|---|---|---|
| "Which do you think was faster, washing with foam or washing with liquid?" Total Sample (100) | Washing with Foam Faster | Washing with Liquid Faster | No Difference |
| % saying: | 51% | 29% | 20% |
| "What are the benefits of touch free soap dispensers?" Total Sample (100) | | % Mentioning | |
| Sanitary (Net) | | 88% | |
| No/less germs | | 72% | |
| More sanitary | | 18% | |
| No need to touch anything | | 17% | |
| No spreading germs/cross-contaminating | | 14% | |
| Convenience of use (Net) | | 51% | |
| Quicker/faster | | 25% | |
| Easier to use | | 19% | |
| Less mess (Net) | | 12% | |
| "When you see touch free soap dispensers in public spaces, such as restrooms, are you:" Total Sample (100) | | % Mentioning | |
| More likely to wash your hands | | 61% | |
| Less likely to wash your hands | | 0% | |
| Makes no difference | | 39% | |

The survey showed that 88% of the study participants believed the touch free dispensers to be more sanitary to use, and 51% believed the touch free was more convenient than other dispensers. Additionally, 61% of participants in the study said they are more likely to wash their hands with touch free dispensers.

## DISCUSSION

This controlled study has demonstrated that foam soap uses 10% less water to rinse than liquid soap. The foam soap was also perceived to be faster to wash and rinse than liquid soap, so the consumer's perceptions aligned with the empirical results.

The water reductions resulted from the format of the soap alone, and did not result from promoting a specific hand wash protocol. These results reinforce the anecdotal evidence that foam soaps are perceived to offer a quicker and more pleasant hand wash experience, with that perception supported by the empirical data.

The cause for the quicker rinsing is likely the result of a combination of the physical properties of the foam soap and the perception the foam soap gives the consumer. From a physical properties standpoint, the foam soap has a lower viscosity, is more wettable, and may spread more easily over the hands compared to a thicker liquid soap.[14] The user's feeling that that the hands are covered more quickly may prompt the rinsing action sooner. Also, it was observed that consumers of liquid soap spend time rubbing their hands together to get a foamy lather. The foam format may create the perception that the hands are already lathered, and that may prompt the rinsing action sooner. Survey of literature shows very little credible research on this topic, so further investigation as to how physical properties and psychological cues impact hand wash behavior is recommended.

The study also shows touch-free soap dispensers were positively perceived as being more sanitary and convenient than other types of soap dispensers. We can conclude that using foam soap in a touch free dispenser creates the perception of a cleaner, quicker, and more hygienic hand wash experience. This means consumers will be more likely to wash their hands, and the promotion of good hand hygiene practices can have positive results on public wellness.[13]

With water scarcity pressures growing and businesses increasing looking for solutions to reduce their water risk, this study shows that foam format soap in a touch free dispenser provides a significant water reducing solution that also promotes healthy hand hygiene.

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## APPENDIX

### U.S. Drought Monitor: California

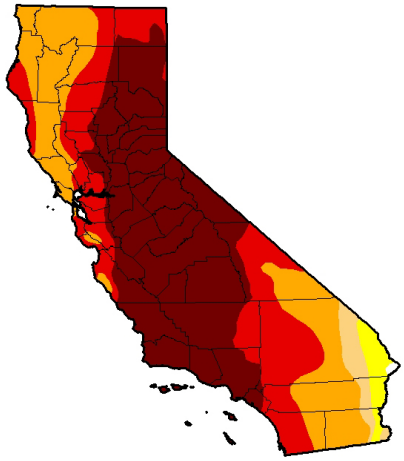

**Figure 1:** California drought conditions as of August 5th, 2014 from the US Drought Monitor.
[ http://droughtmonitor.unl.edu ]

**Intensity:**

- **D0** Abnormally Dry
- **D1** Moderate Drought
- **D2** Severe Drought
- **D3** Extreme Drought
- **D4** Exceptional Drought

### Use of water in office buildings

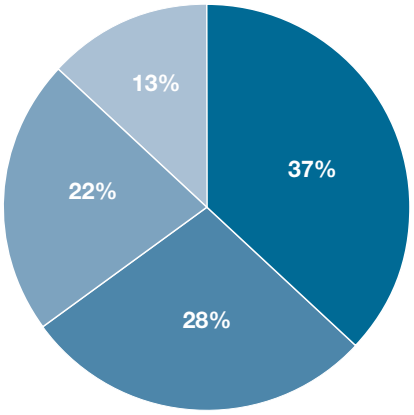


**Figure 2:** Source: EPA US (2009) Water Efficiency in the Commercial and Institutional Sector.
[ http://www.epa.gov/WaterSense/docs/ci_whitepaper.pdf ]

- **Domestic/Restroom**
- **Cooling and Heating**
- **Landscaping**
- **Kitchen and Other**

### Portable hand wash stations

**Figure 3:** Sani-sink hand wash apparatus.
[http://usfirst.biz/wtsproduct/sani-sink/ ]