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Impact of soap type—foaming vs. gel-based—on handwashing time

Danielle M. Conover, Kristen E. Gibson*

University of Arkansas, Department of Food Science, Center for Food Safety, 2650 N Young Ave, Fayetteville, AR 72704, USA

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ABSTRACT

Handwashing (HW) is used daily in the food service industries to prevent disease transmission. Limited published research into the efficacy of foaming handsoap exists when compared to gel-based handsoap. Understanding how foaming soap may affect HW behavior as represented by time is critical to maximize HW effectiveness and minimize transmission of foodborne pathogens. Here, 12 participants completed a baseline HW, and then applied a known amount of Glo Germ (GG) fluorescent lotion and washed their hands with the assigned handsoap. Hands were then swabbed to quantify the amount of GG remaining on hands. Hand wash and hand rinse times were also recorded. No significant difference in efficacy between soap types was observed 1) in terms of GG remaining ($p = 0.35$) nor 2) in hand wash and rinse times ($p = 0.77$ and $p = 0.48$, respectively). However, consistently longer time (4.5 s on average) in both wash time and rinse time for gel-based handsoap did occur when compared to foaming handsoap. This may indicate a possible benefit to using gel-based handsoap as opposed to foaming types for better protection of public health; however, more research is needed to elucidate these differences.

1. Introduction

Handwashing (HW) is one of the primary means to prevent transmission of infectious diseases. While the general population uses HW as a daily tool to limit the spread of disease, it is especially critical within a food service environment (Todd, Michaels, Smith, Greig, & Bartleson, 2010). Throughout the production and preparation of food, food workers are presented with a variety of scenarios in which hand contact (e.g. direct or indirect) can result in the contamination of food with harmful microorganisms (Todd, Grieg, Bartleson, & Michaels, 2008, 2009; Todd et al., 2010). Despite the focus on HW in the food industry and the establishment of clear guidelines for proper HW via the U.S. Food and Drug Administration (USFDA) *Food Code 2013* (USFDA., 2013) as well as the European Commission (EC) General Food Law Regulation 178/2002 (ECR No, 2002), food workers are still implicated in the transfer of harmful pathogens to food resulting in a significant contribution to the incidence of foodborne illnesses (Green et al., 2006; Hall, 2012; Scallan, Griffin, Angulo, Tauxe, & Hoekstra, 2011; Todd, Grieg, Bartleson, & Michaels, 2007).

The USFDA *Food Code 2013* (Section 2–301.12) states that food employees must wash hands as well as exposed portions of the arm for 20 s, designating at least 10–15 s of this HW process to vigorously rubbing the hands together (USFDA., 2013). Similarly, EC guidelines on hand hygiene specifically state that hands must be washed for 30 s dedicating 20 s to rubbing 'soap-smeared' hands together and 10 s to rinsing the hands while rubbing together under running water (Bonne, Wright, Camberou, & Boccas, 2005). Guidelines for when food employees should wash their hands are fairly standard including after 1) using the toilet room, 2) coughing, sneezing, blowing nose, etc., 3) handling soiled equipment or utensils, and 4) handling specific types of food to prevent cross-contamination. Additional actions that warrant HW include when moving from raw food production areas to cooked food product areas and before placing gloves on hands to work with food. Although food safety regulatory bodies as well as many other organizations—World Health Organization, the Mayo Clinic, and U.S. Centers for Disease Control and Prevention—recommend at least a 20 s handwash, numerous studies have reported that food service workers as well as the general population often complete the HW process in 15 s or less (Bonne et al., 2005; Burton et al., 2011; Soap and Detergent Association, 2007; Strohbehn, Sneed, & Paez, 2008). Reasons for lack of compliance with the recommended HW time vary; however, a recent study by Seimetz, Boyayo, and Mosler (2016) indicate that psychosocial factors (self-efficacy, action planning, and remembering to perform a specified behavior) were most important for understanding hygiene behaviors including deviance from recommended HW times.

* Corresponding author.
E-mail address: keg005@uark.edu (K.E. Gibson).

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In order for HW to be as effective as possible, it is essential to understand how all of the different variables associated with the actual HW process will affect the end result. As reviewed in Conover and Gibson (2016a), the primary factors influencing the efficacy of the HW process include soap volume, HW time, plain vs. antimicrobial soap, and drying technique. However, it should be noted that results related to the significance of each of these factors on HW are inconsistent in the published literature. Another variable recently explored is the difference in hand soap types—foaming and gel-based—in the level of microbial reduction (Conover & Gibson, 2016b). The primary differences between foaming and gel-based handsoaps are the level of surfactant and additional salt compounds. Foaming soaps generally have lower levels of surfactants and salts compared with gel-based soaps. As a result, foaming soaps do not form micelles as readily as gel-based handsoap (personal communication provided by M. Caetta, VCI Formulation Specialist at GOJO Industries, Inc.) thus possibly reducing the removal of dirt and oils as well as microorganisms.

In comparison to gel-based handsoaps, foaming handsoaps are relatively new with the first appearance on the market in 1999 (Deb Group Ltd, 2014). Therefore, it is important to determine if the efficacy of foaming handsoaps is equal to that of traditional, gel-based handsoaps. One aspect of this is to understand how people respond to these foaming handsoaps with respect to total HW time—a primary factor influencing HW efficacy (Conover & Gibson, 2016a). The primary objectives of this study were 1) to determine if handsoap type (foaming versus gel-based) affects HW time and 2) to investigate whether a fluorescing compound remaining on hands after HW could be quantified and correlated with HW time differences between soap types. The use of the fluorescing compound, Glo Germ, is more commonly used to qualitatively observe HW behavior (Biran et al., 2009; Ling & How, 2012). Typically, participants rub the fluorescent lotion onto their hands, wash their hands, and then participants view their hands under a blacklight in order to visualize where the fluorescent compound is remaining, thus indicating the areas missed during HW. Therefore, the potential quantitative application for evaluating various HW variables, specifically HW time, is a novel aspect of the present study.

2. Materials and methods

2.1. Study design

Studies were arranged in a paired *t*-test design. To account for any possible confounding factors, two blocking factors were incorporated into the statistical model. These included sequence and participant. Two experimental sequences occurred to alternate exposure of participants to soap type and to adjust for any possible confounding factors (e.g., learning by either the researchers or the study participants over the two weeks of the study). The study was completed over a two-week period in November 2015 with one-week in between visits for different soap types.

2.2. Participant recruitment

Twelve participants (six men and six women) from the University of Arkansas (Fayetteville, Arkansas) community were recruited to wash their hands. Participant age ranged from 19 to 72 years with an average age of 30 years old. Participants were required to have no known conditions of the skin nor any broken skin (ASTM., 2013). University of Arkansas Institutional Review Board approval was obtained prior to participant recruitment, and informed consent was received for all participants.

2.3. Selection of soaps

Two unscented, non-antimicrobial soaps were chosen for use in the study. The soaps did not have identical formulations, but were selected as surrogates for handsoaps widely available on the market and used daily. Two automatic dispensers, one foaming (GOJO Industries, Akron, OH) and one gel-based (Epare, Staten Island, New York), were chosen to standardize the soap volume. One dispense of foaming soap was 0.9 mL (after foaming subsided), and one dispense of gel-based handsoap was 1.5 mL. Based on preliminary, unpublished data on average soap volume at 68 food service locations in Washington County, Arkansas, the soap dispensers selected for this study were determined to be representative of the average soap volume used in the patron-accessible restrooms of food service facilities.

2.4. Baseline handwash

On each study day, participants completed a preliminary handwash to remove any possible physical contamination (e.g., residues from hand lotions, organismic materials, etc.) present on their hands. Participants did not receive any direction as to how to complete the handwash since the objective of the study was to detect differences in the time spent washing and rinsing hands by soap type. The following steps were performed: 1) wetting hands, 2) provided with designated handsoap, 3) dispensed the desired amount of soap (number of pumps recorded), 4) lathered hands for desired amount of time (time recorded), and 5) asked researcher to turn on faucet and rinsed hands for desired amount of time (time recorded). After completion of these steps, participants were instructed to flick their hands 10 times to remove excess water and then air-dry at ambient temperature. Hands were then immediately swabbed in the three locations as discussed in Subsection 2.6, and the swabs were then processed as described in Subsection 2.7. Swabs from this step were considered “baseline” swabs.

2.5. Fluorescing compound handwash

Following the preliminary HW and air-drying, hands were air-dried for an additional 30 s or until hands appeared visibly dry. Participants were then provided with Glo Germ (GG) lotion (Glo Germ Company, Moab, UT) that contains a fluorescing compound with individual units approximately the size of a bacterial cell (about 5 μm) (Kilbride, Wirtsschafter, Powers, & Sheehan, 2003). Participants were provided with 1.0 ± 0.01 g (i.e. approximately the size of a quarter) of GG lotion as recommended by the manufacturer. Next, the participants thoroughly rubbed the lotion into their hands (both palmar and dorsal sides) for 1 min until evenly distributed and absorbed. Hands were air-dried for 30 s or until hands appeared visibly dry. Once dry, participants completed a second handwash as described previously in Subsection 2.4.

2.6. Swabbing participant hands

Based on the findings of Taylor (1978), the skin between the thumb and index finger was chosen for swabbing as well as the lower nail bed/skin region of the middle finger and the palmar side of the wrist. To quantify the amount of GG remaining on hands after washing, sterile, foam tipped swabs (VWR, Radnor, PA) were placed in a 15 mL centrifuge tube containing 2 mL of 95% ethanol, and both hands were swabbed in 3 locations (Fig. 1a–c) using one swab for each location (i.e. 3 swabs total for each participant).