

Irritancy potential of 17 detergents used commonly by the Indian household

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ABSTRACT

Background: Detergents are used by almost every household in the developed and developing world. Soap and most detergents are anionic surfactants and attack the horny layer of the skin and increase its permeability with little or no inflammatory change and may result in hand eczema, which is very distressing and incapacitating. **Aim:** To evaluate the irritant potential of common household detergents (laundry and dish wash) used by the Indian population using a 24-hour patch test and to convincingly educate the patients on the detergents less likely to cause irritation in the particular individual. **Methods:** Seventeen commonly used detergents found in Indian market were included in the study, of which, 12 were laundry detergents (powders – seven, bar soap – five) and five were dish wash detergents (powder – one, liquid – one, bar soap – three). The irritant potential of the 17 detergents were evaluated in 30 volunteers. Thirty microliters of each of the detergent bar solutions, distilled water (negative control), and 20% SDS (positive control) were applied to Finn chambers with a micropipette and occluded for 24 hours. Erythema, scaling, and edema were graded in comparison to the reaction at the negative control site (distilled water) for each volunteer separately. The scoring of erythema / dryness and wrinkling on a 0 – 4 point scale and edema on another 0 – 4 point scale was based on the Draize scale. The pH of each of the detergent solutions was determined using litmus papers (Indikrom papers from Qualigens fine chemicals). **Results:** The difference between detergents (F value) was significant for erythema / dryness and wrinkling (F = 3.374; p = 0.000), but not significant for edema (F = 1.297; p = 0.194). Table 2 lists the means for erythema / dryness and wrinkling, and edema. The F value of the totals of the means for erythema / dryness and wrinkling and edema was significant (F = 2.495; p = 0.001). The pH of all the detergents was found to be alkaline except Pril utensil cleaner which tested acidic (pH 6). The positive control, 20% SDS also tested acidic (pH 6). **Conclusion:** Similar to patch testing in allergic contact dermatitis, 24-hour patch testing with detergent solutions (8% w/v), will educate the patient on what detergent to avoid. This may bring down the total medication requirement and frequent hospital consultations for these patients.

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Key words: 24-hour patch test, detergents, hand eczema, sodium dodecyl sulfate (SDS)

INTRODUCTION

Detergents are used by almost every household in the developed and developing world. Women bear the brunt of involving wet work with detergents at home and in occupation (nursing staff, kitchen workers, and cleaners). The resultant eczema, predominantly localized to the hands following irritation caused by detergents, is very distressing and incapacitating.

In spite of advertising claims of relative mildness of a particular detergent powder or cake, doctors are frequently confronted with the question “Which detergent powder or detergent cake should I use?” from patients suffering with chronic hand eczema. Most of these patients are likely to be atopics who have defective barrier function and thus are more prone for skin irritation. Mere prescription of a detergent powder or cake does not convince these patients

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on its suitability and compatibility on their skin. Investigations on detergent-induced skin irritation have been limited. Irritant potential of soaps / cleansers in the Indian market, in a 24-hour patch test has been reported.^[1] Sodium dodecyl sulfate (SDS) also known as sodium lauryl sulfate (SLS) is the most widely used chemical to study skin irritation in man. In our study, 20% SDS was included as the positive control.

We evaluated the irritant potential of common household detergents (laundry and dish wash) used by the Indian population in a 24-hour patch test. This would convincingly educate the patients on the detergents less likely to cause irritation in the particular individual.

METHODS

Thirty volunteers (29 female; one male), were included in the study. To standardize the testing for irritant potential of detergents, three volunteers were patch tested with 8% (w/v) solution of Rin Advanced, Power detergent cake, Arasan detergent cake, 501 bar soap, Henko Stain Champion, distilled water (negative control) and 20% SDS (positive control). Readings were taken at four hours and 24 hours of occlusion, for erythema, scaling, and edema. As readings after four hours of occlusion were not satisfactory, we took readings after 24 hours of occlusion and graded them for erythema, scaling, and edema on a 0 – 4 point scale, erythema / dryness and wrinkling on another 0 – 4 point scale (Draize scale for scoring the treatment sites).^[2]

Seventeen commonly used detergents found in the Indian market were included in the study, of which, 12 were laundry detergents (powder – seven, bar soap – five) and five were dish wash detergents (powder – one, liquid – one, bar soap – three). The irritant potential of the 17 detergents was evaluated in 30 volunteers.

The bar soaps were grated to chips, 8% (w/v) solutions of detergents were made in distilled water with moderate warming. Thirty microliters of each of the detergent bar solutions, distilled water (negative control), and 20% SDS (positive control) were applied to Finn chambers with a micropipette and occluded for 24 hours. The anterolateral surface of the forearm was used as a test site for all the volunteers, to avoid variations in sensitivity due to different sites. Three circular pieces of filter paper 5 mm in diameter or the

size of the office punch (595 Schleicher and Schuell Rundfilter Ø 125 mm, Dassel, Deutschland) were first placed in the Finn chamber. With a 10 µl pipette, a total of 30 µl of detergent solution was applied and allowed to soak without spillage. The patches were removed after 24 hours and the sites were graded for erythema, scaling, and edema, 30 minutes after removing the patches. Erythema, scaling, and edema were graded in comparison to the reaction at the negative control site (distilled water) for each volunteer separately. The scoring of erythema / dryness and wrinkling on a 0 – 4 point scale and edema on another 0 – 4 point scale was based on the Draize scale for scoring the treatment sites [Table 1].^[2]

The pH of each of the detergent solutions was determined using litmus papers (Indikrom papers from Qualigens Fine Chemicals, Worli, Mumbai, Maharashtra)

Statistical analysis was performed using SPSS (Version 11.5). Means with SD and ANOVA (F-value) were computed separately for each soap, with respect to the two parameters, erythema / dryness and wrinkling and edema. The total of the means of these parameters was also calculated. The detergents were listed based on this total from the least irritant to the most irritant [Table 2].

RESULTS

Thirty volunteers (29 - female, one - male) participated in the study with their ages ranging from 20 years to 22 years (mean of 20.73 years)

All the volunteers showed varying degrees of irritant reactions to detergents at the tested sites, among different volunteers. The site at which positive control (20% SDS) was applied also showed varying degrees of erythema / dryness and wrinkling and edema. There were no ulcers at the site of application of 20% SDS. The erythema score was 0 in three volunteers; 1 in nine volunteers; 2 in nine volunteers, and 3 in nine volunteers. The edema score was 0 in 22 volunteers; 1 in one volunteer; 2 in six volunteers, and 3 in one volunteer. The intensity of erythema / dryness and wrinkling and edema was graded in comparison with the distilled water (negative control) site.

The pH of all the detergents was found to be alkaline except Pril utensil cleaner, which tested acidic (ph of 6) [Table 2]. The positive control, 20% SDS was also acidic (pH 6).

Table 1: Draize scale for scoring the treatment sites^[2]

Score for erythema/ dryness and wrinkling	Reaction	Score for edema	Reaction
0	No reaction	0	No reaction
1	Very slight erythema / dryness with shiny appearance	1	Very slight edema
2	Slight erythema / dryness / wrinkling	2	Slight edema
3	Moderate erythema / dryness / wrinkling	3	Moderate edema
4	Severe erythema / wrinkling / scales	4	Severe edema

Table 2: Comparison of irritant potential of common household detergents used by Indian population (means with standard deviation)

Detergent name	pH	Erythema / dryness and scaling	Edema	Total
Discount detergent powder	10.5	0.3 ± 0.54	0 ± 0	0.3
Henko stain champion	9	0.4 ± 0.62	0 ± 0	0.4
Ariel oxy blue	10.5	0.3 ± 0.56	0.07 ± 0.37	0.44
Tide	10.5	0.37 ± 0.49	0.07 ± 0.37	0.44
Nirma washing powder	10.5	0.33 ± 0.55	0.13±0.51	0.46
Rin advanced	10.5	0.37 ± 0.67	0.13 ± 0.51	0.5
Pril utensil cleaner	6	0.6 ± 0.86	0 ± 0	0.6
Surf excel quick wash	10.5	0.67 ± 0.71	0±0	0.67
Active wheel gold	10.5	0.53 ± 0.86	0.27 ± 0.69	0.8
Vim dish wash bar	9.5	0.8 ± 0.93	0.07 ± 0.37	0.87
Arasan detergent cake	10.5	0.7 ± 0.92	0.2 ± 0.61	0.9
Sabeena dish wash powder	8	0.73 ± 0.87	0.2 ± 0.67	0.93
Exo dish wash bar	8.5	0.83 ± 0.87	0.13 ± 0.51	0.96
New sunlight	10.5	0.67 ± 0.88	0.33 ± 0.88	1
Power pax dish wash bar	9.5	0.93 ± 0.87	0.07 ± 0.37	1
Power detergent cake	10	0.9 ± 1.06	0.13 ± 0.51	1.03
501 bar soap	10.5	1.27±0.91	0.07±0.37	1.34
		F value 3.374 P = 0.000	F value 1.297 P = 0.194	F value 2.495 P = 0.001

The study was conducted in the first week of August, 2008, and the average temperature for this period was: Max-30°C, Min-22°C, Mean- 26°C

The difference between detergents (F value) was significant for erythema / dryness and wrinkling (F = 3.374; P = 0.000), but not significant for edema (F = 1.297; P = 0.194). Table 2 lists the means for erythema / dryness and wrinkling and edema. The F value of the totals of the means for erythema / dryness and wrinkling and edema was significant (F = 2.495; P = 0.001)

Discount detergent powder and Ariel oxy blue had the lowest erythema / dryness and a wrinkling score of 0.3 and 501 bar soap had the highest erythema / dryness and wrinkling score of 1.27. Discount detergent powder, Henko stain champion, Pril utensil cleaner, and Surf Excel quick wash had the lowest score of 0 for edema, and New sunlight had the highest score of 0.33 for edema.

Discount detergent powder had the lowest total irritant

score of 0.3 (erythema / dryness and wrinkling score = 0.3 and edema score = 0) and 501 bar soap had the highest irritant score of 1.34 (Erythema / dryness and wrinkling score = 1.27 and edema score = 0.07)

Figures 1 and 2 show the mean score of erythema / dryness and wrinkling and edema, respectively, caused by the common household detergents used in the study. 501 bar soap was found to produce more erythema / dryness and wrinkling when compared to others. Mean score for edema was 0 for Henko stain champion, Pril utensil cleaner, and surf excel quick wash, whereas, it was 0.33 and 0.27 in the case of New sunlight and Active wheel gold, respectively.

Figure 3 shows the total score of irritancy (mean of erythema / dryness and wrinkling and edema) of common household detergents used by the Indian

population. 501 bar soap ranks first and Discount detergent powder ranks last in irritancy ranking among the detergents used in the study

DISCUSSION

Statistical analysis revealed the differences between detergents (F-value) to be significant for erythema / dryness and wrinkling, but not significant for edema. The F-value of the totals of the means for erythema / dryness and wrinkling and edema was also significant.

The 24-hour patch test may be used as a screening test, helping the patient to avoid the detergents that resulted in an irritant response [Figure 4]. This would convincingly answer the patient’s query on “which detergent is safe for my skin?” The detergent solutions can be standardized for irritant potential testing, similar to the standardized battery of antigens used for patch testing for allergic contact dermatitis. The

soap chamber test advocates prolonged five-weekday exposures, which are difficult to carry out routinely.^[3] Twenty-four-hour occlusion simplifies testing and ensures patient cooperation. As some of the detergents could cause great irritability, subjects would be unwilling for prolonged exposures. In addition, adequate irritant responses were elicited by the 24-hour patch tests, to advise our subjects on which detergent to avoid.

Women bear the brunt of handling detergents almost every day in their lives. Regular exposure to low concentrations of detergents used for dish-washing is capable of inducing skin lesions in a substantial proportion of individuals.^[4] Detergents are the common cause for hand eczema in housewives.^[5] As housewives are exposed to detergents daily, they are prone to develop irritant dermatitis.

The active ingredients of detergents are non-soap

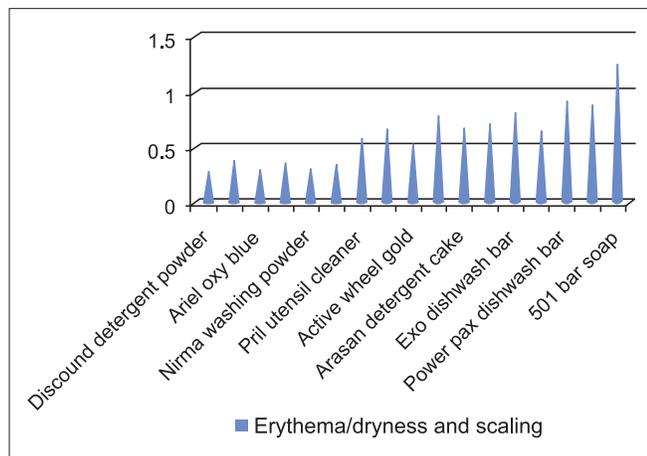


Figure 1: Erythema / dryness and wrinkling

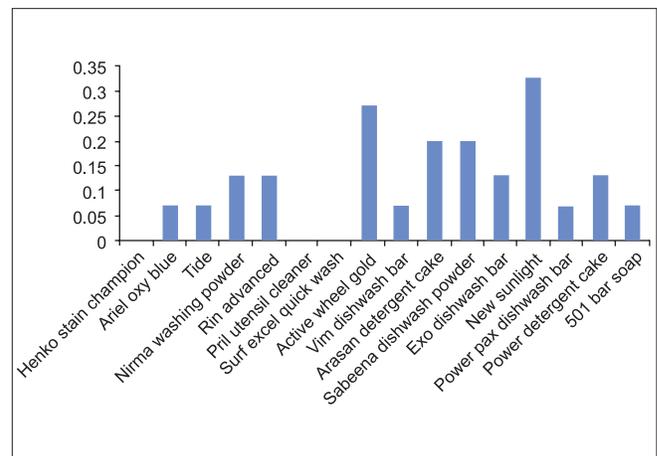


Figure 2: Edema

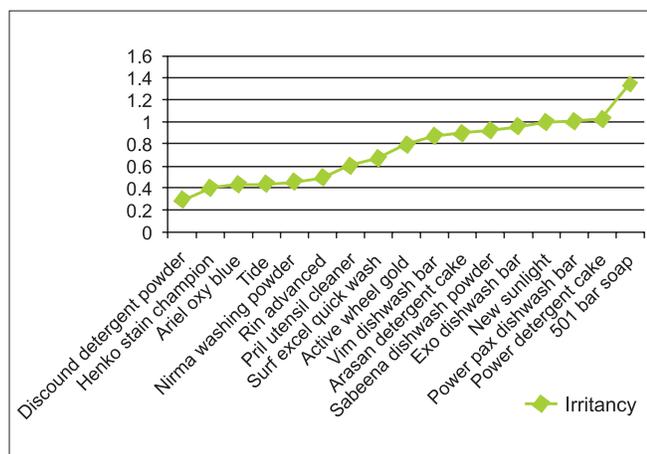


Figure 3: Irritancy



Figure 4: Various degrees of irritation at the tested sites

anionic surfactants, which remain soluble in hard water and make the water more effective when cleaning. Ordinary soap does not lather in hard water, but precipitates to form scum (insoluble calcium soap). The “detergent” does its work and separates the dirt and soil from the fabric or removes the grease from the vessels. Anionic surfactants, including soap, attack the horny layer of the skin and increase its permeability with little or no inflammatory change.^[6] Thus, severe scaling can occur without much erythema. The hallmark of damage by anionic surfactants is “chapping” with a roughened, dry, cracked ruddy surface most evident on the hands, where the horny layer is thick. Thus the irritancy of a soap or detergent is a product of its inherent irritancy and its weakening of the barrier.^[7] Detergents disrupt the stratum corneum barrier function and finally end up in dermatitis. Exposure to detergents increases transepidermal water loss and results in objective skin signs like erythema, scaling, fissures, and subjective symptoms like itching, dryness, and smarting.

There are several laundry detergents available in the market. Most of them contain the anionic surfactant SLS or SDS (sodium lauryl sulfate or sodium dodecyl sulfate) or SLES (sodium lauryl ether sulfate). The usual content of a surfactant in a typical detergent is about 8 – 18%. SLS is found in shampoos, bath gels, car washes, dish detergents, bar “soaps”, laundry detergents, and also in toothpastes. It is a wetting and dispersing agent, emulsifier, and a degreasing and foaming agent.

In powdered or granular solid detergents, the surfactant is soaked into the solid ingredient, in liquid laundry detergents, liquid or even solid surfactants are blended into the liquid detergent. Other constituents of a laundry detergent include various ingredients to control the pH of wash water, builders to enhance the surfactant effect, bleaches, optical brighteners, fillers, perfumes, and fabric softeners. There is a wide scope for development of irritation to various constituents. Irritation is aggravated in patients with an atopic background.^[8] Atopics, by virtue of a compromised barrier, are more prone to develop skin irritation.^[9]

The ‘acid mantle’ of the stratum corneum seems to be important for permeability, barrier formation, and cutaneous antimicrobial defense.^[10] The alkaline pH of detergents in an aqueous solution releases a small quantity of alkali and thus raises the pH of the water.

In addition to increasing permeability, the high pH of the detergent also contributes to the detergent-induced irritant effect. The skin surface is slightly acidic, giving the concept of the acid mantle. Thus, pH is an important indicator of a cleanser or detergent’s irritant potential.

The least irritant dish wash detergent was Pril Utensil Cleaner, which showed an acidic pH (pH6). The laundry detergents with alkaline pH like Discound detergent powder, Henko Stain Champion, Ariel Oxy Blue, Tide, Nirma washing powder, and Rin Advanced had a lower irritant potential compared to Pril Utensil Cleaner. Therefore, pH is not the only factor determining the irritant potential of a detergent. Laundry detergents may contain other ingredients like sodium carbonate and sodium bicarbonate to help control the pH of the wash water, which may act as a buffer.

Hand eczema is very common in housewives, nurses, cleaners, and in those with an atopic background, and has the potential to disrupt the normal life either at home or in the workplace. This may lead to conflict both at home and the workplace. Similar to patch testing in allergic contact dermatitis, 24-hour patch testing with detergent solutions (8% w/v), will convincingly educate the patient on what detergent to avoid. This may bring down the total medication requirement and frequent hospital consultation for these patients.

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