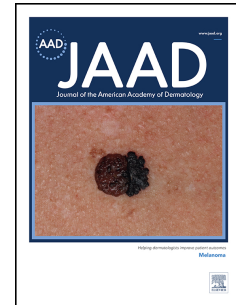


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Comparison of the formulation and allergenic potential of “clean” and traditional shampoos

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A growing trend in the cosmetic industry is the distinction of “clean” personal products. This claim, which is not regulated, is meant to conjure that safe, natural ingredients are used; however, varying definitions exist (sup table 1).¹⁻³ Without any criteria to define what makes a product “clean,” we compared the ingredients of “clean” and traditional shampoos (i.e. shampoos not labelled as clean) to determine how their formulations and allergenic potential differ.

Three stores that commonly sell clean shampoos were selected: Sephora, Ulta, and Target. Shampoos classified as “clean” on these sites were identified; all others were classified as traditional shampoos. The use of a self-described “clean” designation was confirmed by visiting each product’s website. Contents were assessed and tabulated for the presence of allergens in the American Contact Dermatitis Society core series. Statistical differences between the two groups were calculated using the Fisher’s exact test.

A total of 85 “clean” and 124 traditional shampoos were identified (**table 1**); the brands manufacturing these products are shown in **table 2**. The most notable difference between the two were preservatives: some “clean” shampoos were less likely to use allergenic chemicals such as methylisothiazolinone (1% vs 36%, $p<0.01$), methylchloroisothiazolinone (1% vs 32%, $p<0.01$), and iodopropynyl butylcarbamate (0% vs 9%, $p<0.01$). However, similar rates of less allergenic preservatives were observed: sodium benzoate (61% vs 60%, $p=0.89$), benzyl alcohol (37% vs 25%, $p=0.07$) and sorbic acid (7% vs 6%, $p=0.77$). Phenoxyethanol was slightly less common

in “clean” shampoos (41% vs 56%, $p=0.04$). None of the “clean” products used parabens (0% vs 9%).

Fragrance was found in 100% of “clean” and 99% of traditional shampoos. When assessing individual fragrance components, greater rates of cinnamal (9% vs 34%, $p<0.01$), hexyl cinnamal (8% vs 34%, $p<0.01$), and cinnamic aldehyde (9% vs 35%, $p<0.01$) were found in traditional shampoos. Among other chemicals, propylene glycol and BHT were less common in “clean” shampoos (60% vs 15%, $p<0.01$) and (15% vs 1%, $p<0.01$), respectively.

Overall, the most distinct difference in formulation is that traditional shampoos use more allergenic ingredients. Methylisothiazolinone/methylchloroisothiazolinone and propylene glycol, which ranked as the second and eight most detected allergen in the 2017-2018 North American Contact Dermatitis Group data, were more common in traditional than “clean” shampoos.⁴ However, this is not to say “clean” products are hypoallergenic: 100% of “clean” shampoo contained fragrance, which can be irritating and/or allergenic.

Perhaps not surprisingly, none of the “clean” products used parabens. Parabens are a safe and effective preservative, but there is skepticism of their safety amongst the public.⁵ The disclaimer “clean” suggests a natural and non-toxic product, and given the public’s fear, it is not unexpected that these products would avoid parabens.

82 Ultimately, “clean” remains an unregulated product disclaimer with various proposed
83 definitions (supp table1).¹⁻³ Based on our findings, clean shampoos are less likely to use
84 allergenic and controversial preservatives, however, they use fragrance as often as
85 traditional shampoos. Differences in formulation alone cannot predict if “clean”
86 shampoos are more or less likely to cause irritant or allergic contact dermatitis in real-
87 world settings. Ongoing research to identify these differences are needed.

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Table 1 Comparison of listed ingredients in the ACDS standard series between self-identified “clean” and traditional shampoos

Ingredient	Clean	Traditional	p-value
Total	85	124	
Fragrance and Botanicals			
Fragrance/ Parfum	67 (79%)	123 (99%)	<0.01
Linalool	23 (27%)	54 (44%)	0.02
Limonene	18 (21%)	48 (39%)	0.01
Cinnamal	8 (9%)	42 (34%)	<0.01
Hexyl cinnamal	7 (8%)	42 (34%)	<0.01
Cinnamic aldehyde	8 (9%)	42 (34%)	<0.01
Coumarin	5 (6%)	16 (13%)	0.11
Citronellol	5 (6%)	14 (11%)	0.23
Geraniol	8 (9%)	9 (7%)	0.61
Hydroxycitronellal	1 (1%)	8 (6%)	0.09
Lavender absolute	8(9%)	8 (6%)	0.44
Tea tree oil	4 (5%)	5 (4%)	1.00
Eugenol	0 (0%)	1 (1%)	1.00
Citral	1 (1%)	1 (1%)	1.00
Jasmine	2 (2%)	1 (1%)	0.57
Peppermint	7 (8%)	1 (1%)	0.01
Balsam of Peru	3 (4%)	1 (1%)	0.07
Ylang-ylang	1 (1%)	0 (0%)	0.41
Any fragrance	85 (100%)	123 (99%)	
Preservatives			
Sodium benzoate	52 (61%)	74 (60%)	0.89
Phenoxyethanol	35 (41%)	70 (56%)	0.04
Methylisothiazolinone	1 (1%)	45 (36%)	<0.01
Methylchloroisothiazolinone	1 (1%)	40 (32%)	<0.01
Benzyl alcohol	32 (37%)	31 (25%)	0.07
Ethylhexylglycerin	21 (25 %)	18 (15%)	0.07
Benzoic acid	7 (8%)	17 (14%)	0.27
DMDM hydantoin	5 (6%)	12 (10%)	0.44
Parabens	0 (0%)	11 (9%)	0.00

Iodopropynyl butylcarbamate	0 (0%)	11 (9%)	0.00
Sorbic acid	6 (7%)	7 (6%)	0.77
Diazolidinyl urea	0 (0%)	4 (3%)	0.15
Any preservatives	85 (100%)	124 (100%)	

Surfactants

Cocamidopropyl betaine	43 (51%)	85 (69%)	0.01
Decyl glucoside	11 (13%)	26 (21%)	0.15
Lauryl glucoside	10 (12%)	12 (10%)	0.65
Cocamide DEA	0 (0%)	3 (2%)	0.27
Amidoamine	7 (8%)	3 (2%)	0.09
Dimethylaminopropylamine	0 (0%)	2 (2%)	0.52
Any surfactants	85 (100%)	124(100%)	

Other additives

Propylene glycol	13 (15%)	74 (60%)	<0.01
Tocopherol	12 (14%)	23 (19%)	0.45
Benzyl salicylate	6 (7%)	22 (18%)	0.04
2, 6-ditert-butyl-4-cresol (BHT)	1 (1%)	18 (15%)	0.00
2-Ethylhexyl-4-methoxycinnamate	0 (0%)	8 (6%)	0.02
Benzphenone-4	0 (0%)	6 (5%)	0.08
Cetyl steryl alcohol	2 (2%)	2 (2%)	1.00

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Table 2 Companies by type of shampoos produced

Clean	Adwoa Beauty, Alba Botanica, Anomaly Haircare, ArtNaturals, Authentic Beauty Concept, Bread Beauty Supply, Briogeo, Dae, Drunk Elephant, Fable and Mane, Fekkai, Fresh, Goop, Innersense Organic Beauty, Jason, Love Beauty and Planet, Native, NatureLab. Tokyo, Not Your Mother's Naturals, Noughty, Odele, Pacifica, Playa, Puracy, Purezero Clean Beauty, Rahua, Raw Sugar, Renpure, Reverie, Rhyme & Reason, Rossano Ferretti Parma, Sienna Naturals, Spring & Vine, Sukin, Together Beauty
Traditional	AG Hair, ALTERNA Haircare, American Crew, Aussie, Bed Head, Blackwood for Men, Bumble and Bumble, Chi, Christophe Robin, Clairol Professional, Drybar, Eva NYC, Grande Cosmetics, Hair Biology, IGK, It's A 10, John Frieda, Kenra Professional, Kérastase, Kiehl's, L' Anza, Lime Crime, Marc Anthony, Matrix, Moroccan Oil, Neutrogena, Novex Mystic, OGX, Old Spice, Oribe, Palmers Coconut Oil Shampoo, Pantene Pro-V, Pattern, Quai, Quidad, Rita Hazan New York, Sebastian, Sexy Hair, Shu Uemura, Sol de Janeiro, Sun Bum, Vanicream, Wella Professional
Both	BioSilk, Dove, Garnier Fructis, Joico, L'Oreal, Nexxus, Paul Mitchell, Redken, Suave Essentials, TRESemme