

Objective Comparison of Shampoo Bars, Natural and Synthetic

By Kerri Mixon

Shampoo bars and synthetic shampoos have different effects on hair. Learn which ingredients are commonly added to cold process soap to make shampoo bars. Understand the chemical and physical effects of natural and synthetic shampoos, how the effects vary by ethnic hair structure, and the added benefits of using a conditioner. This presentation focuses on hard scientific facts, not subjective perspectives or opinions.

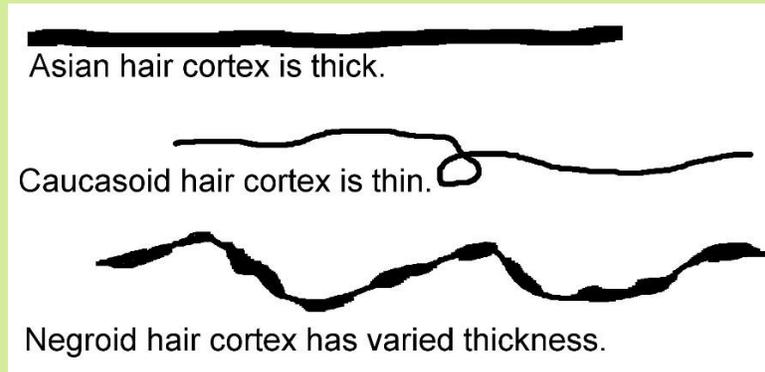
As a 16th generation professional soapmaker for 20 years, I thought I had shampoo bar soaps down cold. I thoughtfully formulated my shampoo soaps with 10–15% castor oil to yield a thicker, longer-lasting lather and chose herbal infusions beneficial to hair, such as henna, chamomile, sage, horsetail, and rosemary. I'd always heard hair products needed to have a lower pH, so I included small amounts of organic apple cider vinegar (which is acidic) to help lower the pH of my shampoo soaps and I included small amounts of citric acid (also acidic) to act as a mild chelating agent and pH buffer.

My customers seem to enjoy my shampoo soap bars and regularly re-order my shampoo soap bars and my liquid soap shampoo, so I thought all was well. I know Lush and other companies make synthetic detergent bars marketed as solid shampoos, but detergents aren't my thing—and I know my customers don't want anything to do with synthetic detergents!

I have a strong background in biology and chemistry, so when Leigh O'Donnell asked me to prepare a comparison of soap shampoo bars versus detergent shampoo bars, I jumped at the chance to prove soap as the superior champion, once and for all. I thought this presentation right up my alley because I already understand quite a bit about hair physiology. Terminal hair (as opposed to vellus hair) consists of the medulla, the cortex, and the cuticle. The cortex is like a hollow straw or bamboo reed; it is made mostly of keratin and gives hair its strength and structure. The cortex also contains the melanin that determines hair color. The inner core of the cortex is the medulla, which is an irrelevant structure of air pockets and proteins; vellus hair (like arm or leg hair) lacks an inner medulla. The outermost layer wrapped around each strand of hair is the cuticle. The cuticle exists in one-directional layered sheets, similar to ordered roof tiles or fish scales. The cuticle protects the cortex but is easily subject to damage from friction, chemical processing, UV light, heat appliances, and other external forces. When hair is wet, the cuticle layer temporarily absorbs water and swells, which leaves the cuticles protruding and more easily subject to damage.



From a biological standpoint, there are 3 main ethnic hair types: mongoloid (Asian, Hispanic, or Indian), caucasoid (white or European), and negroid (black or African). Mongoloid hair structure has a thicker cortex, which makes the hair straight, thick, and less prone to breakage. Caucasoid hair has a thin cortex, which makes the hair fine, more easy to curl, and easier to break. Negroid hair has a cortex of varied thickness, which makes the hair curly and ultra-susceptible to breakage in the thinner areas.



I always believed the job of any surface active agent was to remove excess sebum and dirt. I also knew soap seemed to do the job without stripping the skin of all oil and without leaving skin dry, tight, and uncomfortable. My customers often shared stories of skin dryness and irritation after using products containing the synthetic detergent sodium lauryl sulfate, which is known to be fabulous for household cleaners but too harsh for sensitive skin. Of course, I assumed all detergents had this overly cleansing effect and soap was the answer to the issue. Despite my bias in favor of handmade soap, I diligently tested different shampoo bar products and tried to maintain an impartial scientific mindset.

First, like a flash, I took to the Internet to find a scholarly article related to the effects of the pH of hair products. I found a phenomenal article entitled, *The Shampoo pH can Affect the Hair: Myth or Reality?* by Maria Fernanda Reis Gavazzoni Dias, et alia, at the US National Library of Medicine. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4158629/>

“The scalp pH is 5.5, and the hair shaft pH is 3.67. An alkaline pH may increase the negative electrical net charge of the hair fiber surface and, therefore, increase the friction between the fibers. This may lead to cuticle damage and fiber breakage. It is a reality and not a myth that lower pH of shampoos may cause less frizzing for generating less negative static electricity on the fiber surface. In this work, we review the action of the surfactants and the influence of the pH on the hair fiber friction, regarding the electrical charges on the surface of the shaft and its consequences on the frizz effect. Friction, the main cause of frizz, can be minimized by adequate formulation of cleaning products, which is particularly important for African hair and curly hair. We also analyze the pH of 123 commercially available shampoos of international brands. Interestingly, only 38% of the popular brand shampoos against 75% of the salons shampoos presented a $pH \leq 5.5$.”

Second, I did some shopping and chose test products based on Amazon's best sellers, Amazon's recommended products, my own shampoo soap, my own DIY detergent shampoo bar, and a few liquid shampoos for comparison.

Third, armed with my scale, calculator, phenolphthalein, and a pH meter, I ran an arsenal of fun tests on the products. The findings from my assorted tests are in the spreadsheet in the following pages.

Last, I tried them all—the good, the bad, and the ugly. I was shocked when I hated how my hair felt after using my own shampoo soap bar; my hair felt, dry, stripped, and almost crispy-crackly. I could tell the high pH of the shampoo soap bar did leave the hair cuticle raised and un-sealed. My wonderful customers must use a powerful conditioner after washing with my shampoo soap bar. I did not try the JR Liggett's shampoo soap bar because it failed the phenolphthalein test, had a dangerously high pH reading, and possibly contained excessive or unreacted sodium hydroxide. The Ethique shampoo detergent bar had a nice feel to the lather while I was using it, but my hair felt rather brittle after it was rinsed and dried, maybe because it did not contain any conditioners (cationic quaternary compounds to adsorb to damaged areas), film formers (hydrolyzed proteins), or cationic polymers (to seal and coat the hair cuticle with a thin protective lubricant for slip and glide). The Ethique bar is nice when finished with a conditioner to provide the necessary finishing ingredients, but it was not acceptable without a conditioner. The Nexxus liquid shampoo met my expectations; it did the job but was nothing special. The shampoo detergent bar I loved that exceeded all of my expectations was the one I made myself. My hair definitely feels healthier after using it and I plan to eventually do away with my high pH shampoo soap bar and sell a version of the DIY shampoo detergent bar. The various detergents I used are biodegradable, ECOcert certifiable, and are naturally sourced from coconut, colza plant, and apple amino acids. My DIY shampoo detergent bar formula is below, with a recipe for 200 grams—or 2 bars.

DIY Shampoo Detergent Bar Formula and Recipe

30.0%	sodium cocoyl isethionate	60.0 grams
19.0%	cocamidopropyl betaine	38.0 grams
5.0%	sodium cocoyl apple amino acids	10.0 grams
27.0%	sodium lauryl sulfoacetate	54.0 grams
4.0%	BTMS-50	8.0 grams
2.0%	sodium lactate	4.0 grams
4.0%	distilled water	8.0 grams
2.0%	panthenol	4.0 grams
2.0%	hydrolyzed rice or quinoa protein	4.0 grams
2.0%	fragrance	4.0 grams
2.0%	cyclomethicone	4.0 grams
1.0%	dimethicone	2.0 grams

Ingredients: Sodium cocoyl isethionate, sodium lauryl sulfoacetate, cocamidopropyl betaine, sodium cocoyl apple amino acids, water, hydrolyzed rice protein, panthenol, sodium lactate, behentrimonium methosulfate, fragrance, cyclomethicone, cetyl alcohol, butylene glycol, dimethicone.

My presentation includes photographs and additional information not in this handout. Please attend to find out what else I learned about shampoo and hair health.

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Brand	Ethique	Aspen Kay	Whiff	DIY Shampoo Bar	JR Liggett's	Pallas Athene Soap	Nexus	Everyone 3-in-1 Soap
Shampoo Type	bar	bar	bar	bar	bar	bar	liquid	liquid
Price	\$16.00	\$13.99	\$8.84	\$15.00	\$6.50	\$7.99	\$16.99	\$10.99
Quantity	3.8 oz	3.2 oz	1.6 oz	3.5 oz	3.5 oz	4.2 oz	33.8 oz	32.0 oz
Cost per Ounce	\$4.21	\$4.37	\$5.53	\$4.29	\$1.86	\$1.90	\$0.50	\$0.34
Primary Surfactant	SCI sodium cocoyl isethionate	SCI sodium cocoyl isethionate	SCS sodium coco-sulfate	SCI sodium cocoyl isethionate	soap	soap	coco-betaine	cocamido-propyl hydroxy-sultaine
Secondary Surfactant	decyl glucoside	n/a	n/a	SLSa sodium lauryl sulfoacetate	n/a	n/a	SCI sodium cocoyl isethionate	SCS sodium coco-sulfate
Tertiary Surfactant	SCS sodium coco-sulfate	n/a	n/a	sodium cocoyl apple amino acids	n/a	n/a	cocamido-propyl betaine	coco-glucoside

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Brand	Ethique	Aspen Kay	Whiff	DIY Shampoo Bar	JR Liggett's	Pallas Athene Soap	Nexus	Everyone 3-in-1 Soap
Multiple Surfactants for Mildness	✓ passed	✗ failed	✗ failed	✓ passed	✗ failed	✗ failed	✓ passed	✓ passed
Phenolphthalein Test	✓ passed	✓ passed	✗ failed	✓ passed	✗ failed	✓ passed	✓ passed	✓ passed
pH Meter Test	pH 3.5	pH 4.0	pH 9.4	pH 4.3	pH 10.2	pH 9.8	pH 6.1	pH 5.6
Within pH 4.0 to 5.0 Range	✗ failed	✓ passed	✗ failed	✓ passed	✗ failed	✗ failed	✗ failed	✗ failed
Personal Experience During Use	✓ passed	✗ failed	✗ failed	✓ passed	✗ failed	✗ failed	✓ passed	✓ passed
Personal Experience of Hair Feel After Use	✗ failed	✗ failed	✗ failed	✓ passed	✗ failed	✗ failed	✓ passed	✗ failed

Conclusions:

According to the scholarly article in the International Journal of Trichology, safe shampoos that do not damage hair must be acidic and between pH 4 and pH 5.

All soap bars are alkaline and greater than pH 7; therefore, soap is not safe for use on hair because it is not between pH 4 and pH 5.

Some synthetic detergents, such as sodium lauryl sulfate (SLS, pH 8), are alkaline and greater than pH 7; therefore, some synthetic detergents are not safe for use on hair because they are not between pH 4 and pH 5.

Some synthetic detergents, such as sodium cocoyl isethionate (SCI, pH 5), are acidic and lower than pH 7; therefore, some synthetic detergents are safe for use on hair because they remain stable when acidic additives lower the final product pH to between pH 4 and pH 5.

A variety of different mild synthetic detergents must be used to ensure the maximum recommended quantity of each detergent will not be exceeded.

8 Points to Improve Shampoo

1. First, **pH** is key! Hair care products that are too alkaline or too acidic can damage the hair shaft on contact or can leave the cuticles raised and prone to breakage. Using products only ranging from pH 4 to pH 5 will leave the cuticles sealed down flat.
2. **Panthenol**, or pro-vitamin B5, is an absorbable form of pantothenic acid (vitamin B), which is a major constituent of hair. Panthenol is used to naturally make the hair shaft more pliable so it can bend, curl, and move without snapping or breaking.
3. **Quaternary compounds**, such as behentrimonium methosulfate (BTMS from colza plant) and honeyquat, adsorb to hair. Adsorption is the physical property of lightly accumulating through electron attraction. Quaternary compounds are positively charged and are attracted to the negative charge of the hair shaft. They are substantive and form a light coating to seal, protect, condition, and lubricate the hair shaft. They do not build-up excessively and wash off easily during the next shampooing.
4. **Dimethicone** and some silicone replacement systems are emollient ingredients that lightly condition the hair shaft to give it tremendous shine and lubricity. Dimethicones eliminate static electricity in hair and protect hair from absorbing excessive moisture that can lead to breakage. The moisture barrier and film-forming properties of dimethicone are excellent for protecting brittle hair and African hair types from frizz and breakage. Dimethicone is one of only 3 additives approved by the FDA for use as a protectant.
5. Excessive **humectants**, such as glycerin and sodium lactate, should be avoided in brittle hair types, especially in African hair types. Humectants draw moisture from the air into the hair shaft and plump it, which raises the cuticles slightly; raised cuticles promote cuticle breakage and damage. Very straight hair and Asian hair types don't break as easily as African hair types and have more body and curl when humectants are applied.

6. **Hydrolyzed proteins** (such as oat, rice, bamboo, and silk proteins) also help to seal the cuticles down flat to protect the hair and promote lubricity, glide, and slip to prevent breakage. Hydrolyzed proteins lightly coat without building-up on the hair shaft and they are not tacky or sticky; they are a great choice for oily hair types.
7. When it comes to detergents, a **combination of different mild detergents** is best. Using a combination of different detergents produces a milder product by ensuring the maximum recommended quantity of each detergent will not be exceeded.
8. Back to pH, if using a combination of mild synthetic detergents without a low enough pH, small quantities of **acidic additives** (such as citric acid, glycolic acid, hyaluronic acid, or vitamin C) may be added to lower the overall pH of the shampoo product.

Resources:

<https://www.amazon.com>

<https://www.cir-safety.org/>

<https://www.epa.gov/saferchoice/safer-ingredients>

<https://www.ewg.org/skindeep>

<http://www.fda.gov/ForIndustry/ColorAdditives/ColorAdditiveInventories/ucm115641.htm#table3A>

<http://www.lotioncrafter.com>

<https://www.p65warnings.ca.gov>

The Shampoo pH can Affect the Hair: Myth or Reality? by Maria Fernanda Reis Gavazzoni Dias, et alia, at the US National Library of Medicine, 2014.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4158629/>

Soap and Cosmetic Labeling: How to Follow the Rules and Regs Explained in Plain English by Marie Gale, Cinnabar Press, Oregon, 2015.

<https://swiftcraftymonkey.blog>