# Sustainable Beauty with Green and Multi-Functional Cosmetics: Development of Bottleless Shampoo Bar with Scalp Soothing Traditional Chinese Medicinal (TCM) Plant Extracts

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## Introduction:

As public interest in sustainability continues to climb, the cosmetics industry is greening up, taking steps in various ways trying to make a difference to the environment in terms of ingredients, formulations, production practices and packaging methods used in their beauty products. In this regard, a packaging-free hair-cleansing product is envisioned to serve as a great alternative to liquid shampoo that often comes in non-biodegradable plastic bottles.

However, conventional soap bars derived from salts of fatty acids are known to exhibit high pH values, making them do more damage than good to the scalp. To tackle this problem, a novel solid shampoo bar without soap-base surfactant has been formulated. Important features of this formulation include: (1) a physical hardness similar to a conventional soap bar, and the entire fabrication process can be performed with conventional soap production lines without additional or unusual processing steps; (2) a scalp-friendly pH (5.5), and its detergency, foam quality, and effect on hair combability are comparable with conventional liquid shampoos; (3) a formulation which has a high ingredient tolerance, making the formulation highly opened to modification. The last point has been demonstrated by the successful incorporation of extract from magnolia officinalis, a traditional Chinese medicinal (TCM) plant which contains anti-inflammatory ingredients magnolol and honokiol. Encouragingly, the scalp-soothing efficacy of this extract in our solid shampoo bar has also been confirmed by clinical study. While eco-friendly products are often considered to be unattractive and functionally inferior, all the benchmark tests have proven that our shampoo bar is no worse but even better than their liquid counterparts. And unlike chemicals commonly found in liquid shampoo, natural ingredients of the shampoo bar that get washed down the drain are fully biodegradable, causing no harm to aquatic life.

In short, the developing prospect of our zero waste solid shampoo bar serving as the perfect alternative to liquid bottled shampoo is well anticipated as it genuinely embraces the essence of sustainability.

## Materials & Methods:

**Formulation of shampoo bar**
Sodium Cocoyl Isethionate (50-70%), Glycerin (5-15%), Coco-Glucoside (5-15%), Sodium Lauryl Sulfoacetate (1-10%), Hydrolyzed Soy Protein (0.5-2%), Theobroma Cacao (Cocoa) Seed Butter (0.5-2%), Magnolia Officinalis Bark Extract (0.5-2%), Glyceryl Caprylate (0.5-2%), Cocos Nucifera (Coconut) Oil (0.1-1%), Hydrolyzed Jojoba Esters (0.1-1%), Butyrospermum Parkii (Shea) Butter (0.1-1%), Citrullus Lanatus (Watermelon) Seed Oil (0.1-1%), Chlorophyll-Copper Complex (0.01-0.1%).

**Figure 1.** A 20-gram shampoo bar prototype based on our proposed formulation

** This shampoo bar, denoted as sample D, has a physical hardness comparable with conventional soap bars even though it has no soap-base surfactants.

**Chinese Remy hair tresses** (24 cm × 2 cm; natural black) were (ca. 50 g) were pretreated by 10% (w/v) sodium lauryl sulfate (SLS) solution.

**Table 1.** Details of shampoo samples in this work

| Sample | Sample Descriptions | Stock Solution Concentration |
|---|---|---|
| A | Liquid shampoo with sodium laureth sulfate (SLES) as surfactant | 1.0% (v/v) |
| B | Liquid shampoo without silicone and sulfate; a well-known brand in Mainland China | 1.0% (v/v) |
| C | Liquid shampoo without silicone and sulfate; a well-known brand in Hong Kong SAR | 1.0% (v/v) |
| D | Our solid shampoo bar | 0.4% (w/v) |

**Test of shampoo samples**
1. Determination of pH
2. Foam Quality Evaluation (Cylinder shake method)[1]

**Performance test**
Wet and Dry Combing Evaluations: Performed by Dia-Stron miniature tensile tester MTT175. The ease of combing was expressed as residual combing work which is defined as:

$$residual\ combing\ work\ (\%) = \frac{average\ combing\ work\ for\ shampoo\ treated\ tresses}{average\ combing\ work\ for\ control\ tresses} \times 100\%$$

**Figure 2.** Combing evaluation performed by miniature tensile tester

Comb at top position  Comb at bottom position

**Composition of the artificial sebum (Spangler sebum)** [2] for detergency evaluation:
Olive oil (20%), Coconut oil (15%), Oleic Acid (15%), Spermaceti (15%), Palmitic acid (10%), Paraffin Wax (10%), Cholesterol (5%), Squalene (5%), Stearic acid (5%)

Detergency Evaluation: The amount of sebum remained on hair sample after washing with samples was determined by a hexane extraction method. The dried residue was weighed and the detergency power ($DP$, an expression of soil removal efficiency) of a shampoo sample was calculated as:

$$DP = \frac{C - T}{C} \times 100\%$$

where $C$ and $T$ are the weight of sebum in the control and shampoo-treated hair tress portions, respectively [3].

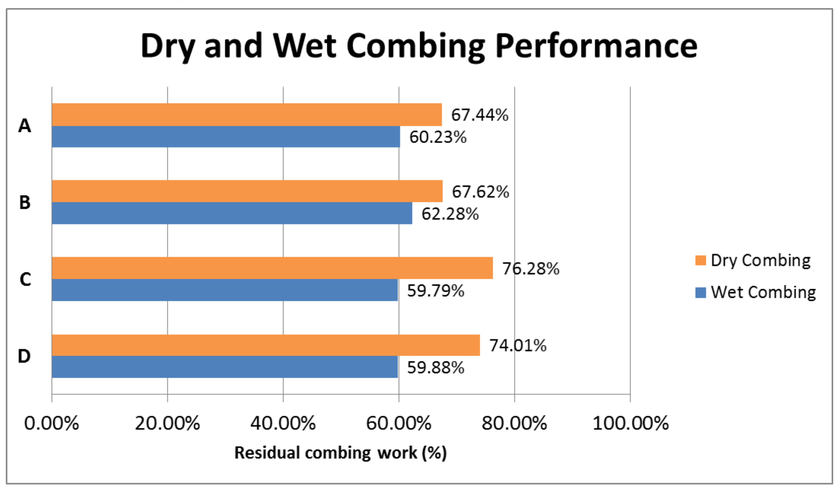
## Results & Discussion:

**Table 2.** pH, foaming volume and detergency power for stock solutions of **A**−**D**

| Sample | pH | Foam Volume at 0 & 5 minutes (ml) | Detergency Power (%) |
|---|---|---|---|
| A | 6.36 | 160, 160 | 65 |
| B | 5.81 | 180, 180 | 50 |
| C | 6.07 | 108, 104 | 63 |
| D | 5.81 | 200, 200 | 62 |

**The pH, foam quality and detergency power of **D** has been benchmarked with three other liquid shampoos available in the market (samples **A**−**C**) and the results are summarized in Table 2. Sample **D** possesses a scalp-friendly pH (5.81) similar to other traditional liquid shampoos. Moreover, its detergency power (62%) is comparable with samples **A**−**C** which range from 50−65%. Notably, sample **D** possesses a more superior foaming ability than **A**−**C**, and the foam was found to be stable for at least 5 minutes.

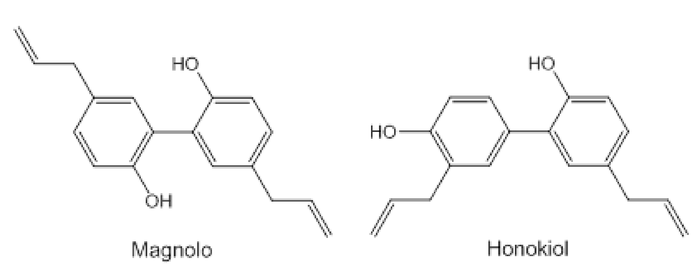
**Figure 3.** Residual combing work (%) for shampoo samples **A**−**D**




**The ease of combing for both wet and dry hair tresses treated with samples **A**−**D** was evaluated by comparing the work needed to comb the shampoo-treated and -untreated hair tresses using a miniature tensile tester (Figure 2). The results were expressed as residual combing work; the lower the value, the easier the shampoo-treated tresses to be combed. As seen in Figure 3, sample **D** exhibits similar wet and dry combability when compared with conventional liquid shampoo samples **A**−**C**.

Encouragingly, our solid shampoo bar formulation has a high ingredient tolerance. For example, we have successfully incorporated the extract from magnolia officinalis, a traditional Chinese medicinal plant, into our formulation. The major active substances in the extract are Magnolol and Honokiol (Figure 4), which have been demonstrated to possess anti-inflammatory, anti-oxidation, anti-bacterial and anti-angiogenesis functions [4,5].

**Figure 4.** Chemical structures of Magnolol and Honokiol




## Conclusions:

We have successfully developed a bottleless shampoo bar which serves as a perfect alternative to conventional bottled liquid shampoos. This product is anticipated to bring a positive impact to the environment and the image of the cosmetic industry as the reduction in packaging would definitely help alleviate the problem of plastic pollution.

## Aknowledgments:

The work described in this paper was supported by the Hong Kong Innovation and Technology Commission (UIM/379) and City University of Hong Kong (9678122).

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