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Evaluation of Shampoo by *Quality Control*: Review

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Abstract

Shampoo is a product that is used to clean hair from dirts and also for specific therapeutic objectives such as conquering dandruff and hair loss. Product evaluation is a step that cannot be avoided to ensure product quality, including shampoo. As stated in the Good Manufacturing Practice guidelines, in the process of releasing product, the quality control in pharmaceutical industry must guarantee that the appropriate tests have been performed. The purpose of this review is to determine what attributes need to be evaluated in shampoo preparations. Datas for this review were obtained from national and international scientific publications published in the last 10 years using websites such as PubMed, Science Direct, and Springer. The keywords used in the search process are shampoo, evaluation of shampoo, types of shampoo. Final number of articles that used are 50 articles. Based on the search results, it is concluded that the evaluation of shampoo preparations consisted of testing physical appearance, homogeneity test, pH, solid content, viscosity, cleansing ability, and others.

Keywords: Shampoo, quality control, products evaluation.

1. Introduction

Hair is a part of the body that serves both decorative and protective functions. Hair has decorative functions since it can improve people's look and protective functions because it shields the head from impacts and other disruptions (1). Because hair is the body's outermost layer, it is impervious to the damaging effects of sun exposure, pollution, cosmetic components, and other cleansing agents. Therefore, hair's health is important and inextricably linked to everyday bodily care. The commonly found hair problems are dandruff and hair loss (2). Dandruff is a common skin ailment that affects about 50% adult population globally (3). Signs of dandruff are excessive redness, itching, and scalp exfoliation (4). Meanwhile, hair loss is a dermatological condition that is influenced by physical and psychological stress (5).

Shampoo is one of the most commonly used cosmetic products in daily life to treat the scalp and hair (6). Shampoo is a product that contains a surfactant in an appropriate form (liquid, solid, or powder) to clean the hair shaft and scalp of oil, dirt, and skin debris (7). The primary principle of shampoo is to clear the scalp from sebum and other contaminants, however shampoo can also be used for medicinal purposes, which is known as therapeutic shampoo (8). Shampoos are categorized into numerous categories according on their specialized

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tasks, including general-purpose shampoos, conditioning shampoos, anti-dandruff shampoos, baby shampoos, and dry shampoos. Shampoos are generally made as solutions, emulsions, liquids, creams, pastes, gels, and others (9).

One of the duties of quality control is to carry out a releasing procedure that ensures that all relevant tests have been carried out, therefore a test is required to ensure that the quality formed from the start of the product production process is maintained until the product is released (10). Therefore, the shampoo must be evaluated beforehand, which consists of visual assessment, measurement of pH, viscosity, wettability, and others (11).

2. Method

The method used in this Literature Review is to search through Google on the web as the Science Direct (Elsevier), Springer, PubMed. The data sources used are scientific books and national and international journals published during the last 10 years. The keywords used in the search process are shampoo, evaluation of shampoo, types of shampoo. The inclusion criteria are articles about type of shampoos, formulation and evaluations of shampoo while the exclusion criteria are articles about formula optimization and articles that are not meet the criteria needed.

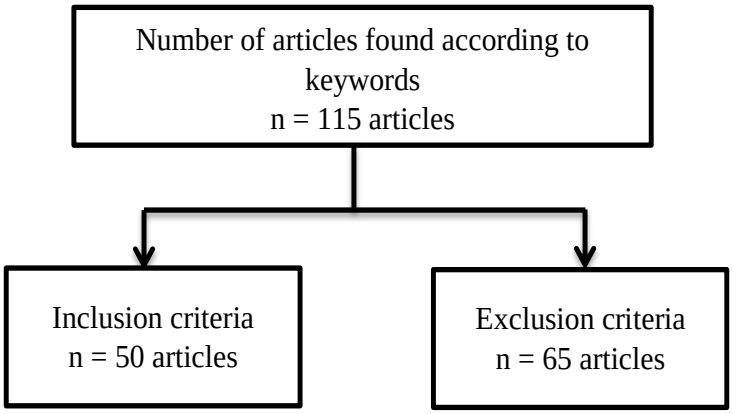

Figure 1. Flowchart of methodology

3. Result

Hair is an important element of the body that serves as an indicator of health. Hair is made up of three parts: bulbs, roots, and stems that are lodged in pilosebaceous follicles in the dermis. The hair bulb is the deepest end of the hair and is related to the dermal papilla, which is rich in innervation and vascularity thus provides nutrients for hair growth (12). The hair root is firmly attached in the hair follicle, which is placed between the hair bulb and the epidermis' surface. On the outside, the hair root and shaft are composed of three equal concentric layers: the medulla, cortex, and cuticle. The medulla is the center core of the cortex, which includes the hair's largest and thickest part (13). The cuticle is a layer that is highly resistant of overlapping dead cells by forming a protective barrier against the external environment and external aggressions. The cuticle made up by endocuticle and exocuticle (14). Normal cuticles have a smooth appearance, allow light reflection, and prevent friction between hair shafts, and are important for the luster and texture of the hair (12).

Shampoo is a hair care product that cleans the hair and scalp. Shampoo is typically offered in the form of a thick liquid and also, although not commonly, in powder form. The ultimate goal of using shampoo

is to get rid of the unwanted impurities that have accumulated on the hair and its antimicrobial properties will prevent infection of the scalp without exfoliating much of sebum or making the hair unruly (15).

Shampoos are made up of 10-30 components that are categorised according to their different activities. These ingredients include cleansing agents called surfactants that remove sebum, conditioning agents that promote softness of the hair, active compounds that treat certain disorders like dandruff, and additives like preservatives that help to the product's durability and comfort. Every ingredient is tested, approved, and is listed on the product label (16).

As a pharmaceutical preparation, shampoo must be evaluated to ensure that the quality that is built into the product is as required or intended. The following tests are used to evaluate a shampoo preparation:

1. Physical appearance/visual assessment
   Examine the preparation's shape, fragrance, and color (17).
2. Homogeneity test
   The presence or absence of coarse particles in the shampoo formulation was carried out to determine homogeneity. Various concentrations of shampoo were applied to the watch glass and then monitored. The shampoo must exhibit a homogeneous composition and no visible coarse granules (18).
3. Determination of pH
   The pH of the shampoo can affect hair quality, minimize eye irritation, and maintain the scalp's ecological balance. Furthermore, one of the elements to limit hair damage is pH (19). If the shampoo's pH is too alkaline, it might induce swelling of the hair shaft, resulting in hair damage (20).
   The pH was determined at room temperature using pH paper; the universal pH is dipped in the shampoo formulation and then examining the color changes on the pH paper. The pH range of the preparation is then determined by comparing the color created with the pH indicator (21). The quality requirements of pH value specified by SNI is between 5.0 and 9.0 (22). In this pH range, it can prevent hair damage (23).
4. Solid content
   One of the physical parameters used to determine shampoo quality is solid content. A shampoo with a low solids content makes the shampoo runny and could be dried rapidly from hair, whereas a shampoo with a high solids content is difficult to be formulated and rinsed from hair (24). This test carried out by weighing a clean and dry steam dish and then adding 4 grams of shampoo to the steam dish. Place the steam dish containing the shampoo on the hot plate until the liquid portion evaporates. Then, weigh the preparation (solids) after drying (25). A solids concentration of 20-30% is considered the optimal range for commercial shampoos (26).
5. Viscosity
   The viscosity of shampoo reflects the quantity of solid substance in the mixture. Viscosity plays an important role in defining many shampoo attributes such as spreadability and consistency. The higher the viscosity, the better the consistency of the shampoo. This is due to the fact that viscosity is associated with a larger gel fraction (27). Furthermore, shampoo viscosity affects shelf-life stability and product aesthetics such as clarity, ease of flow from the box, spreadability when it is applied to hair, and product consistency in the packaging (28). Viscosity

measurements were carried out using a Brookfield Viscometer. The shampoo preparation to be tested was poured into a beaker glass (±200 mL), then it was placed under the Brookfield DV-E model viscometer with an appropriate spindle. The spindle is then put into the preparation until it is completely submerged. Measurements were taken after one week and four weeks of storage (29).

6. Cleansing action
   Another important parameter in determining a shampoo's cleansing capacity is dirt dispersion; a good quality shampoo concentrates dirt in the water, whereas a poor quality shampoo concentrates filth on the foam preparation. Any dirt or stains that become concentrated in the lather will be difficult to rinse off and thus will be deposited in the hair. Shampoo that concentrates dirt or stains in water is effective in cleansing (27). This test is performed by placing 0.1 mL of shampoo in a test tube and then adding water until the amount reaches 10 mL. Then, add 2 droplets of liquid ink to the tube, close it, and shake it 10 times. Observe the amount of ink dispersed in the foam, and ensure that the ink remains in the water portion (state qualitatively) (21).
7. Foaming ability and stability
   The volume and stability of the foam are the most important factors in determining shampoo quality and consumer approval (30). The presence of foam reduces any friction, which reduces the occurrence of hair damage (31). Furthermore, the presence of foam makes it easier to wash the hair and keeps the hair shafts from sticking together, resulting in tangles (32). Shampoos with the highest bulk (stated by volume) and the longest time to keep their volume are considered to be the most desirable. A good shampoo product is one that has a large volume of stable lather after shaking (27). The foam height is determined by making a 2% solution in 500 ml of water. The solution should then be transferred to a 1 L flask. Then, pour 50 mL of test solution into a 1 L measuring cup and set it beneath the flask's top. Pour the 500 ml solution in the flask into a measuring cup containing 50 ml of the test solution. Examine the height of the foam after 0.5, 3, 5, and 7 minutes (33). The foam height requirement is 1.3-22 cm (34).
8. Surface tension
   Surface tension is measured at 25°C with a Du Noüy ring tensiometer (35). This apparatus works by measuring the force required to remove the platinum and iridium rings from the liquid surface (36). Furthermore, measurements could also be taken with a stalagmometer by preparing shampoo that has been diluted to 10% with distilled water at room temperature. First, wash the stalagmometer with chromic acid and pure air because oil or other lubricants can negatively damage the surface tension (37). Then, measure the amount of solution that falls between the two predetermined points (three times for each shampoo solution) (38). The surface tension is measured by the following equation:

$$R2 = (W_3\text{-}W_1)\ N_1 \text{ x } R_1 \ (W_2\text{ -}W_1)\ N_2$$

   Keterangan:
   W1: weight of empty beaker.
   W2: weight of beaker with distilled water.
   W3: weight of beaker with a shampoo solution.
   N1: the number of distilled water droplets.

N2: number of drops of shampoo solution.
R1: surface tension of distilled water at room temperature.
R2: surface tension of shampoo solution (39).
A good shampoo preparation can reduce the surface tension of pure water from 72 to less than 40 dyne/cm 25°C. Surfactants and other compounds that diminish the surface tension of the air have an effect on its effectiveness. Therefore, shampoos that diminish water's surface tension have strong detergency (cleansing ability) (27).

9. Wetting ability
Shampoo's wetting ability is depending on the concentration of surfactant in the formulation. A higher surfactant concentration will result in better wetting ability. The shampoos with highest demand are those with the shortest wetting time. Shampoo formulations with shorter wetting times contain more detergent (27). Thus, the lesser time it takes to remove the shampoo from the hair, the better cleansing ability the shampoo has (40). Wetting time is calculated by timing how long it takes for the shampoo to completely wet the canvas paper. Then weigh the canvas before cutting it into 1-inch-diameter discs. After that, place a disc of canvas paper on the surface of the shampoo (1% v/v) and time how long it takes for the paper to absorb the shampoo using a stopwatch (41).
10. Conditioning performance
The conditioning performance of shampoo depends on its chemical properties. Shampoos generally contain conditioning polymers that deposit, adhere to, or absorb into hair proteins. The polymer increases the ease of styling, reduces static, and makes hair soft and smooth. The shampoo's conditioning effect was evaluated by first washing the cut hair mass with the shampoo preparation and then performing physical observations (27). Conditioning performance criteria are graded on a scale of 1 to 4, with 4 being very good, 3 being good, 2 being satisfactory, and 1 being poor (42).
11. Specific gravity
One of the physical analyses performed to determine the stability of the shampoo during storage is specific gravity, because knowing the specific gravity may also establish the purity value of the shampoo (43). The specific gravity measurement is carried out using a pyrex pycnometer. The pycnometer is cleaned first, then dried and allowed to cool. Then, weigh and record the weight of the empty pycnometer (A). The pycnometer is then filled with water until it is completely full and no air remains. Clean the pycnometer's neck with a clean towel before weighing it. Next, record the weight of a pycnometer filled with water (B). Following that, the pycnometer is cleaned and dried. Then, pour a sample of the shampoo preparation into the pycnometer. Weigh and record the weight of the sample-containing pycnometer (C). Set the measurement conditions to a temperature of 25°C (21).
12. Microbial examination
Mix 100 microliters of shampoo preparation with liquid Mueller Hinton agar and pour it into sterile petri dishes under aseptic conditions. The container is rotated to thoroughly mix the contents before it starts to harden. Following that, the plate was incubated at 37°C for 24 hours and the microbial growth was detected (44).
13. Antimicrobial activity

The diameter of the zone of inhibition indicates the relative activity of the different antibacterial agents against the pathogen under investigation (45).

14. Antimicrobial preservative effectiveness test
    The preservatives used in shampoos are the most synthetic preservatives to prevent degradation due to microbial growth as well as undesired chemical changes (46). Thus, the efficiency of preservatives used in shampoo must be assessed because it influences the product's quality. To assess the efficiency of preservatives, 20 mL of shampoo and 0.1 mL of microbial suspension were prepared, then poured to each test tube and stored at room temperature for 7, 14, 21, 28 (and 35 days for C. Albicans) days. After that, take 1 ml of each tube's contents and place it on two sterile dishes. Then, add 15-20ml of TSA agar at 40°C to it. Store the agar at 37°C for 24 hours after it harden (47).
15. Stability study
    Thermal stability testing is performed by placing the shampoo formulation in a glass tube and storing it in a room with humidity levels of 45°C and 75% relative humidity. After that, monitor the appearance and physical stability of the shampoo for three months with one-month intervals (48).

Table 1.1 Evaluation and criteria of shampoo

Evaluation	Criteria
Physical appearance/visual assesment	Shape, fragrance and color as designed
Homogeneity test	Homogeneous composition
Determination of pH	5.0-9.0
Solid content	20-30%
Viscosity	High viscosity
Cleansing action	Concentrates dirt in the water
Foaming ability and stability	The foam height is 1.3-2.2 cm and stable
Surface tension	Less than 40 dyne/cm 25°C
Wetting ability	The shortest wetting time
Conditioning performance	4 = very good ; 3 = good ; 2 = satisfactory ; and 1 = poor
Specific gravity	1.010-1.100
Microbial examination	Less than 10^2 CFU/ml
Antimicrobial activity	No diameter of zone of inhibition correspond to the observed microbes
Antimicrobial preservative effectiveness test	No sign of microbial growth
Stability study	Stable during storage period

The use of shampoo as a cleanser and a source of nutrition for hair is a solution to hair problems due to excess amount of sebum on the scalp and inadequate hair nutrition (49). Criterias of a good shampoo are it could be used for cleansing at the very least, has a stable oil-in-water emulsion, consistent (stable) aroma and color, good

viscosity, close pH value to the physiological pH of the scalp, produce a small, stable, and abundant foam, does not irritate the skin, and has microbial contamination within the allowable range (50).

4. Conclusion

Before a product is approved by the quality supervisor in the pharmaceutical industry, it must first meet the acceptance criteria that have been set. Shampoo preparations that meet the acceptance standards are guaranteed to be of high quality. This high quality cannot be obtained by testing the final product alone, rather it must be built from the start of preparation development. In this case, pharmaceutical industry must provide high-quality products that meet the acceptance requirements in order to be well received by consumers.

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