ISSN 2771-7461

TRICHOLOGY AND COSMETOLOGY

Open Journal

Openventio PUBLISHERS

Original Research

Quality Assurance of General Purpose, Keratin Based and Dye lock Hair Shampoos

Saima Siddique, PhD[1*]; Zahida Parveen, PhD[1]; Zeeshan Ali, PhD[2]; Sidra Mehmood, BS (Hons)[3]

[1]*Applied Chemistry Research Centre, PCSIR Labs Complex, Lahore, Pakistan*
[2]*Applied Physics Computer and Instrumentation Centre, Lahore, Pakistan*
[3]*Lahore College Women University, Lahore, Pakistan*

[*]***Corresponding author***
Saima Siddique PhD
Applied Chemistry Research Centre, PCSIR Labs Complex, Lahore, Pakistan; E-mail: saimesiddiquegmail.com

Article information
Received: May 5th, 2024; **Revised:** August 6th, 2024; **Accepted:** August 8th, 2024; **Published:** August 23rd, 2024

Cite this article
Siddique S, Parveen Z, Ali Z, Mehmood S. Quality assurance of general purpose, keratin based and dye lock hair shampoos. [In press]. *Trichol Cosmetol Open J.* 2023-2024; 6(1): 16-23. doi: 10.17140/TCOJ-6-121

ABSTRACT

Introduction
Shampooing is a widely used method for enhancing hair beauty, focusing on the cleansing of both the hair and scalp. The shampoos of are different brands are available in local markets of Pakistan.

Objective
The study aims to investigate the compliance of locally available shampoos with the standard established by Pakistan Standards and Quality Control Authority (PSQCA). A total of 47 shampoos were evaluated for their physiochemical properties *viz*; pH, inorganic matter, moisture content, dirt dispersion, foam ability, foam stability and microbiological contamination. The tested shampoos encompassed keratin-based (9), dye-locked (9), and general-purpose (29) variables.

Results
The results of the quality analysis revealed that nearly all of the shampoos met the standards specified by the PSQCA. The pH values of the shampoos ranged between 4 to 8, while the percentage of inorganic matter was found to be within the permissible limit of ≤7%. Additionally, the moisture content of the shampoos did not exceed the maximum threshold of 90%. Moreover, the tested shampoos exhibited satisfactory foaming ability and stability. Notably, the samples were found free from pathogenic bacteria such as *E. coli*, *Staphylococcus aureus*, and *Salmonella*.

Conclusion
The shampoo evaluation tests should be conducted during and after production by regulatory agencies and researchers to assess the quality of different brands.

Keywords
Shampoo; pH; Inorganic matter; Moisture content; Microbiological contamination.

INTRODUCTION

Cosmetics are the products designed to cleanse, beautify, or alter one's appearance and enhance attractive features.[1] When developing a cosmetic care product, several factors need to be considered, including the application area, sensory and visual properties, physical state, active ingredients, product stability, and packaging.[2] Evaluating cosmetics is crucial to assess their performance, quality, and effectiveness, as well as to determine if they pose any harmful effects on the human body.[3] Adhering to the standards set by PSQCA[4] is important to ensure that marketed products meet safety requirements.[5] Failure to meet these standards can lead to various adverse effects, such as skin irritation, eye inflammation, hair loss, protein precipitation, and heavy metal poisoning.[6]

Shampoos are extensively utilized for the daily cleansing of hair and scalp, offering desirable attributes such as softness, shine, and manageability.[7] They encompass a variety of types, including general-purpose, conditioning, anti-dandruff and baby shampoos, each designed to fulfill specific functions.[8] Shampoos can manifest as either transparent or opaque formulations, and are available in various forms such as liquids, gels, lotions, pastes, creams, or dry-powder aerosols.

These formulations consist of surfactants, excipients, and active ingredients.[9] Surfactants serve as agents for cleansing and foaming, while excipients play a role in viscosity control, provide emollient properties, and act as preservatives.[10] Active ingredients may include specialized components such as anti-dandruff agents or essential nutrients.[11] Ensuring the safety of long-term use is a vital consideration in the formulation of shampoos.[12]

To evaluate the performance and quality of different shampoo brands found in local markets, a comprehensive quality assurance study was conducted. This study focused on objective and scientifically measurable physicochemical properties, as well as quality control tests.[13] The evaluation process included visual assessment and the measurement of various parameters, including pH determination, assessment of inorganic matter, moisture content analysis, foam ability measurement, foam stability assessment, and microbiological contamination analysis.[14]

The purpose of these tests was to provide an unbiased and objective evaluation of the effectiveness and quality of shampoos, enabling consumers to make well-informed choices based on reliable information.[15] By considering these scientifically validated parameters, consumers can have confidence in the performance and safety of the shampoos they choose to incorporate into their hair care routines.[16]

MATERIALS AND METHODS

This research work was conducted at Pakistan Council of Scientific and Industrial Research (PCSIR) at Cosmetic and Microbiology lab.

Visual Inspection

The selected samples were evaluated based on their transparency/opaqueness, clarity, color, odor, and texture.

Determination of pH

The pH levels of different shampoo samples were measured directly or by forming 10% water solutions at room temperature using a calibrated pH meter (HANNA pH 211, Microprocessor pH Meter).[17]

Determination of Inorganic Matter

Two (2) grams of shampoo sample was weighed in a crucible and heated it at about 450 °C in a furnace to destroy organic matter. It was than cooled in a desiccator. Few drops of sulfuric acid were added and again heated it to dryness. It was cooled and weighed after heating. Inorganic content was calculated as

$$\text{Inorganic salts, percent by mass} = 100-[(m_1-m_2)/(m_1-m_3)\times 100]$$

Whereas,
m_1=mass, in grams, of the crucible with the sample before heating;
m_2=mass, in grams, of the crucible with the sample after heating;
m_3=mass, in grams, of the empty crucible[4,15]

Determination of Moisture/volatile Content

Ten (10) g of shampoo sample was weighted in a petri plate and heated on a steam bath until most of the volatile had escaped/ dissipated. It was heated at 105 °C in an oven for 2 hours. It was then cooled in a desiccator and re-weighed. Volatile matter was calculated by using formula

$$\text{Moisture/Volatile matter at 105 °C percent by mass} = [(m_1-m_2)/(m_1-m_3)]\times 100$$

where,
m_1=mass, in grams, of the petri plate with the sample before heating;
m_2=mass, in grams, of the petri plate with sample after heating; and
m_3=mass, in grams, of the empty petri plate.[18]

Determination of Anionic Surfactant

Sample was weighed to contain 4 meq of anionic active material and dissolved in deionized water. Few drops of phenolphthalein indicator were added and neutralize to a faint pink color with 1N NaOH or 1N H_2SO_4. The sample was transferred quantitatively to a volumetric flask (250 mL) and diluted upto the mark. An aliquot of 20 mL were taken in a 100 mL stoppered measuring cylinder, 10 mL of water, 15 mL of chloroform and 10 mL of mixed indicator solution were added. The mixture was titrated against 0.004 M Hyamine 1622 solution and was shaken vigorously after each addition of titrant for at least 15 s till the end point reached marked by appearance of blue color. The percentage active anionic ingredient was calculated by using formula

$$=[(V\times N\times EW\times D/(A\times W_3\times 1000)]\times 100$$

where,

V=Hyamine 1622 solution, mL;
N=Normality of Hyamine solution;
EW=gram-equivalent weight of anionic active agent;
D=dilution of solution, mL;
A=aliquot of sample solution, mL and
W_3=Sample mass, g. [ASTM D 3049][19]

Preparation of mixed indicator solution

Stock solution: 0.5±0005 g dimidium bromide was weighed into a 50 mL beaker. 0.25±0.005 g pf disulphine blue was weighed in another beaker. 25-30 mL of 10% hot ethanol was added to each beaker. The contents were stirred till dissolution and transferred to a 250 mL volumetric flask and diluted with 10% ethanol.

Mixed indicator solution: Twenty (20) mL of stock solution were taken in a 500 mL voliumetric flask. Two hundred (200) mL of water and 20 mL of 2.5 M H_2SO_4 was added to it and diluted with distilled water upto the mark.

Preparation of benzethonium chloride 0.004 M solution: 1.75-1.85 g of Hyamine 1622 was dissolved in water and was transferred to 1 L volumetric flask. Zero point four (0.4) mL of 50% NaOH solution were added and diluted upto the mark.

Preparation of Sodium lauryl sulphate 0.004 M solution: 10±0.002 g of sodium lauryl sulphate was taken into a 250 mL round bottom flask and 25 mL of 0.5 N H_2SO_4 were added. It was refluxed under a water condenser for 2 h followed by cooling and titration with standardized 1 N NaOH solution using phenolphthgalein indicator. A blank reading was taken by titratin g 25 mL of 0.5 N H_2SO_4 with standardized 1 N NaOH solution. The purity of sodium lauryl sulphate was calculated as follows:

$$\text{Purity } \% = 28.84 \times (A-B) \times N$$

Standardization of benzethonium chloride 0.004 M Solution: Twenty (20) mL of 0.004 M sodium laurul sulphate solution were taken in a 100 mL stoppered measuring cylinder, 10 mL of water, 15 mL of chloroform and 10 mL of mixed indicator solution were added. The mixture was titrated against 0.004 M Hyamine 1622 solution and was shaken vigorously after each addition of titrant for at least 15 s till the end point reached marked by complete discharge of pink color from chloroform layer.

Foaming Ability and Foaming Stability

The cylinder shake method was used to assess foaming ability. One (1) % solution of shampoo (50 mL) was placed in a 250 mL graduated cylinder at room temperature. The cylinder was covered with hand and shaken ten times. The volume of foam generated after 1 minute was recorded, and the height of the foam was measured immediately. Foam stability was evaluated by recording the foam volume after 20 minutes.[15]

Determination of Dirt Dispersion

One (1)% Shampoo solution was prepared by dissolving 1 g of the shampoo sample in 100 mL of water. One drop of India ink was added to the test tube containing the shampoo solution. The test tube was then stoppered and shaken ten times. After shaking, the amount of ink present in the foam was observed and categorized as none, light, moderate, or heavy.[20]

Stability Studies

The thermal stability of the shampoos was studied by placing them in glass tubes in a humidity chamber at 45 °C with 75% relative humidity as well as in a refrigerator at 4 °C, and comparing them to the same shampoos kept at a room temperature of 25 °C. The thermal stabilities were observed after storage periods of zero, four, and eight weeks. Their appearances and physical stabilities were inspected for a period of two months.[21]

Microbiological Examination

Preparation of Test Sample: Sample dilution was prepared by taking 10 g of shampoo sample to 90 mL of either distilled water or phosphate buffer to obtain 1:10 dilution. The dilution was further used for subsequent analysis i-e. total plate count and pathogenic bacteria *Staphylococcus aureus, E. coli*, *Salmonella spp.*

A sterile pipette was used to transfer 1 mL of dilution into sterile petri plate. About 20 mL of plate count agar (PCA) was added into petri plate and mixed the inoculum with the medium in the plate carefully; it was then allowed to solidify at 45 °C. After solidification, the petri plate was incubated at 35 °C for 48 h. The colonies were counted and the results were recorded as the aerobic plate count per gram of shampoo sample.

***Staphylococcus aureus*:** *Staphylococcus aureus* is a gram positive bacteria. A sterile pipette was used to transfer one mL of dilution into petri plate. About 20 mL of Baid Parker Agar (BPA) were added to the petri plate and mixed the inoculum with the medium in the plate carefully, it was then allowed to solidify at 45 °C. The petri plate after solidifying was incubated at 35 °C for 48 h. The colonies were counted afterwards.

***E. coli* and Salmonella:** These are gram negative bacteria's. Test tubes were taken and Lauryl Tryptose Broth (media) was added to them followed by addition of 1 mL of dilution. No turbidly was indicator of the absence of *E. coli* and *Salmonella spp.*

RESULTS AND DISCUSSION

A total of 47 shampoos (Keratin, Dye-Lock, General purpose) including both imported and locally manufactured were collected from market and tested for different parameters (pH, moisture/volatile content, inorganic matter, microbiological contamination, dirt dispersion, foam ability and foam stability.

A shampoo like any other cosmetic preparation should have good appealing physical appearance. The formulated and marketed shampoos were evaluated for physical characteristics such as color, odor and transparency. The color and odor of the tested shampoos were found to be acceptable by all volunteers.

pH

Shampoo pH levels play a crucial role in improving hair quality, minimizing eye irritation, and maintaining a balanced scalp environment. The majority of shampoos are formulated to be either neutral or slightly acidic. When hair comes into contact with acidic shampoos, the outer layer (cuticle) tends to contract and lay flat along the hair shaft. Conversely, basic shampoos cause the cuticle to swell and open up. As a result, hair treated with acidic solutions appears smoother, whereas basic solutions can lead to frizzy hair The current trend is to promote shampoos with lower pH levels, as they can help reduce hair damage.

The pH of tested commercial shampoos was found within the preferred range (between 7 and 5).

The ideal pH range for hair shampoos is 4.0-8.0 (PSQCA). The tested keratin based, Dye lock and General purpose shampoos showed compliance with PSQCA standard values. The results are summarized in Tables1, 2 and 3.

Table1. *Dirt Dispersion, pH, Moisture Content, Foam ability, Foam Stability and Active Anionic Ingredient of Keratin Based Shampoos*

Company Name	Physical Appearance	Dirt Dispersion	pH	Inorganic Matter (%)	Moisture Content (%)	Foam Ability (ml)	Foam Stability (ml)	Active Anionic Ingredient (%)
Loreal Paris elvive dream long straight keratin shampoo	White creamy colour	None	5.8±0.1	5.65±0.01	74.77±0.01	190±0.1	180±0.1	12.54
Vince Biotin and keratin Shampoo	White colour	Light	6.0±0.1	4.62±0.01	78.16±0.01	140±0.1	125±0.1	12.34
Nutrafix keratin Shampoo	Light brown colour	Moderate	6.4±0.1	5.63±0.01	78.46±0.01	125±0.1	100±0.1	11.80
Vince Intense keratin Shampoo	White colour	Light	6.8±0.1	4.66±0.01	86.07±0.01	135±0.1	120±0.1	12.33
Set and touch keratin Repair Shampoo and conditioner	Creamy white colour	None	4.8±0.1	4.89±0.01	76.14±0.01	145±0.1	130±0.1	12.0
Ottlay keratin Care shampoo	White colour	Moderate	7.1±0.1	5.08±0.01	79.23±0.01	125±0.1	100±0.1	12.89
Eazicare keratin complex shampoo	Light blue colour	None	5.1±0.1	5.53±0.01	87.03±0.01	135±0.1	120±0.1	11.99
Deluxe keratin premium enrichment shampoo	Creamy white colour	None	7.7±0.1	6.11±0.01	75.67±0.01	140±0.1	125±0.1	10.56
Tresemme keratin smooth shampoo	White colour	None	4.3±0.1	3.72±0.01	83.79±0.01	150±0.1	135±0.1	11.50

Table 2. *Dirt Dispersion, pH, Moisture Content, Foam Ability, Foam Stability and Active Anionic Ingredient of Dye Lock Shampoos*

Company Name	Physical Appearance	Dirt Dispersion	pH	Moisture Content %	Inorganic Matter %	Foam Ability (ml)	Foam Stability (ml)	Active Anionic Ingredient (%)
Loreal paris Elvive colour protect shampoo	Brown colour	None	4.8±0.1	79.09±0.01	4.56±0.01	95±0.1	80±0.1	11.78
Tresemme keratin smooth colour protect shampoo	Brown colour	None	4.5±0.1	80.05±0.01	3.67±0.01	90±0.1	75±0.1	11.59
Eazicare colour lock shampoo	Dark Blue colour	None	6.1±0.1	82.78±0.01	1.29±0.01	95±0.1	80±0.1	11.67
Herbal Essences Color Me Happy	Dark brown colour	Moderate	5.6±0.1	83.97±0.01	5.12±0.01	80±0.1	65±0.1	12.10
Tresemme color revitalize shampoo	Brown colour	None	4.6±0.1	80.65±0.01	3.87±0.01	90±0.1	75±0.1	12.0
Pantene Pro-V Brunette Expressions Shampoo	Dark Blue colour	None	5.5±0.1	79.04±0.01	4.43±0.01	80±0.1	65±0.1	11.60
Pureology Pure Volume Shampoo	Black colour	Light	6.1±0.1	81.98±0.01	5.19±0.01	85±0.1	60±0.1	12.60
Pantene Pro-V Color Hair Solutions	Blue colour	None	5.4±0.1	81.34±0.01	6.21±0.01	80±0.1	65±0.1	11.78
Yardlie hair colour shampoo	Black colour	Light	6.6±0.1	85.98±0.01	5.90±0.01	75±0.1	60±0.1	11.65

Inorganic Matter

Thickening of the shampoos may be achieved by inclusion of various types of compounds e.g. electrolytes (NaCl. NH4Cl), cellulose derivatives, carboxyvinyl polymers.[13] Among them sodium chloride is mostly used in commercially available shampoos. However, excessive amount of sodium chloride may strip off moisture from the hair. It may also be the cause of dry and itchy scalp in addition to hair loss.

The accepted inorganic content value by PSQCA is ≤7%. All the tested keratin based, Dye lock and General purpose shampoos showed compliance with PSQCA standard values. The results are summarized in Table 1, 2 and 3.

Moisture Content

Water constitutes roughly 80% of shampoo's weight, acting as a carrier for vital ingredients that offer specific hair benefits. Adequate moisture ensures smoother cleansing, sustains hair flexibility, and guards against external factors like harsh weather, preserving natural hair moisture. Optimal moisture levels prevent tangling and minimize dry hair breakage. Below 70% leads to brittle hair, blocked follicles, and potential loss, while exceeding 90% renders shampoo ineffective, diluting essential components needed for optimal hair care.

All the tested keratin based, Dye lock and General purpose shampoos showed compliance with PSQCA standard value i-e. 70-90%. The results are summarized in Tables 1, 2 and 3.

Table 3. *Dirt Dispersion, pH, Moisture Content, Foam Ability, Foam Stability and Active Anionic Ingredient of General Purpose Shampoos*

Company Name	Physical Appearance	Dirt Dispersion	pH	Moisture Content %	Inorganic Matter %	Foam Ability (ml)	Foam Stability (ml)	Active Anionic Ingredient (%)
Aarch Amla shampoo	Green colour	Moderate	7.4±0.1	83.94±0.01	6.34±0.01	135±0.1	110±0.1	13.55
Aarch egg shampoo	Yellow colour	Moderate	6.8±0.1	79.65±0.01	5.38±0.01	135±0.1	110±0.1	13.45
Heads and shoulder antidandruff shampoo	Creamy white	None	5.2±0.1	77.57±0.01	4.51±0.01	140±0.1	125±0.1	12.65
Heads and shoulder classic clean shampoo	Creamy white	None	5.1±0.1	81.30±0.01	4.47±0.01	140±0.1	125±0.1	12.36
Loreal paris total repair 5 shampoo	Creamy white	None	4.8±0.1	78.33±0.01	5.91±0.01	195±0.1	190±0.1	12.77
Argan Deluxe professionals Argan Oil Nourishing shampoo	Pure white colour	None	6.3±0.1	78.89±0.01	5.93±0.01	140±0.1	115±0.1	12.30
Adore egg shampoo	Yellow colour	Light	6.4±0.1	80.83±0.01	4.41±0.01	135±0.1	120±0.1	13.67
Herbal infusion hair growth shampoo	Black colour	Moderate	5.5±0.1	83.65±0.01	5.10±0.01	130±0.1	110±0.1	13.45
Wellie professional onion anti hair loss shampoo	Pure white colour	None	6.9±0.1	89.36±0.01	4.01±0.01	160±0.1	150±0.1	13.66
Dove silky and straight shampoo	Creamy white	None	4.7±0.1	80.24±0.01	5.26±0.01	140±0.1	125±0.1	12.55
Lifebuoy shampoo strong and shiny	Green colour	None	4.8±0.1	80.39±0.01	3.64±0.01	140±0.1	125±0.1	13.0
Lifebuoy herbal shampoo	Green colour	None	4.7±0.1	81.78±0.01	3.93±0.01	140±0.1	125±0.1	13.21
Sunsilk black shine shampoo	Black colour	None	4.9±0.1	83.23±0.01	5.75±0.01	145±0.1	130±0.1	13.66
Sunsilk hair fall shampoo	White colour	None	4.6±0.1	80.43±0.01	5.01±0.01	145±0.1	130±0.1	13.45
Tresemmne clean and replenish shampoo	Transparent white	None	4.3±0.1	83.20±0.01	5.29±0.01	145±0.1	135±0.1	12.44
Johnson's baby shampoo	Transparent yellow	None	6.3±0.1	79.41±0.01	4.54±0.01	110±0.1	100±0.1	9.0
Berg amla shampoo silky and strong	Green colour	Moderate	6.1±0.1	83.67±0.01	5.81±0.01	130±0.1	105±0.1	13.08
Olina Kalonji Amla Shampoo	Green color	Moderate	5.8±0.1	84.03±0.01	4.83±0.01	130±0.1	110±0.1	13.21
Samsol egg shampoo	Orange in colour	Light	7.4±0.1	81.66±0.01	4.53±0.01	135±0.1	120±0.1	13.11
Hello hair anti dandruff shampoo and conditioner	white colour	None	4.8±0.1	78.88±0.01	6.04±0.01	145±0.1	130±0.1	13.21
Hello hair egg protein shampoo and conditioner	Yellow in colour	None	4.8±0.1	78.79±0.01	6.15±0.01	145±0.1	130±0.1	12.67
Hello hair daily moisturizing shampoo and conditioner	White Colour	Moderate	5.6±0.1	83.97±0.01	5.12±0.01	80±0.1	65±0.1	12.10
Hello hair herbal shampoo conditioner	Light green in colour	None	4.7±0.1	78.76±0.01	6.10±0.01	140±0.1	125±0.1	12.55
Set and touch rich black shine shampoo and conditioner	Black colour	None	4.7±0.1	74.16±0.01	4.71±0.01	145±0.1	130±0.1	12.45
Set and touch long and strong shampoo and conditioner	White colour	None	4.7±0.1	76.20±0.01	4.78±0.01	140±0.1	125±0.1	12.34
Set and touch hairfall solution shampoo	White colour	None	4.8±0.1	76.01±0.01	5.01±0.01	145±0.1	130±0.1	12.45
Herbal essence shampoo	Light brown	Moderate	6.0±0.1	83.16±0.01	6.13±0.01	165±0.1	150±0.1	12.33
Bio amla herbal shampoo	Green colour	Moderate	6.3±0.1	85.07±0.01	6.60±0.01	135±0.1	115±0.1	12.25
Bio black shine shampoo	Black colour	Light	7.4±0.1	70.03±0.01	6.02±0.01	140±0.1	125±0.1	12.33

Foaming ability and Foaming Stability

While the production of foam (lathering) does not directly affect the cleansing efficacy of shampoos, it holds significant value for consumers and consequently serves as a vital parameter in shampoo evaluation.

The standard foaming ability value by PSQCA is ≤200 mL and it should have good stability, the foam should not decrease less than 30 mL. All the tested showed compliance with PSQCA standard value (Tables 1, 2 and 3).

Dirt Dispersion

Efficient dirt dispersion is a crucial parameter for assessing the cleansing efficacy of shampoos. Shampoos that lead to ink concentration within the foam are deemed subpar, as retaining ink or dirt within the foam hinders effective rinsing and can lead to re-deposition onto the hair. Therefore, optimal cleansing is achieved when dirt is predominantly suspended within the water phase. The presence of dirt within the foam poses challenges for thorough rinsing, resulting in potential re-deposition onto the hair. The tested samples were categorized as none, light and moderate based on their dirt dispersion behavior[9] Tables 1, 2 and 3.

Active Anionic Ingredient

The baby shampoos are mild often entirely based on amphoteric surfactants. Shampoos are formulated to clean hair by removing unwanted sebum, dandruff, environmental dust, and residues of hair care products. Most of the dirt including sebum are water insoluble and cannot be effectively removed by water alone. Therefore, a shampoo containing a combination of surfactants is necessary. A combination of surfactants is uses in hair shampoos that include anionic, nonionic and amphoteric surfactants. The efficacy of a hair shampoo on larger part depends on anionic detergent. Anionics provide a lot of the lather and detergency in the shampoo. Nonionics, on the other hand can strip moisture from the hair and lead to scalp irritation due to excessive defatting. They act as foam stabalisers and thickeners in shampoos. Amphoteric surfactants are very useful for decreasing the irritancy of a formulation while increasing the active contents level of the product and quality of the lather produced.

A shampoo must contain > 10% of anionic detergent.[4] All tested showed compliance to PSQCA standard except Johnson baby shampoo. The baby shampoos beinh mild are often entirely based on Amphoterics. Similarly, the Dye lock shampoos and keratin based shampoos being mild showed a lower anionic content 11-12% than General Purpose Shampoo i-e. 12.5-13.0%.

Microbiological Contamination

The presence of bacteria or any other micro-organism in any skin care product may cause bacterial infection. So microbiological screening is very important for skin care products. The pathogenic bacteria (*S. aureus*, *E. coli*, *Salmonella spp.*) should be in shampoos and aerobic plate count should not exceed 300.[4] The most of the tested shampoos appeared free from selected Gram positive and Gram negative bacterial strains and showed <10 aerobic colonies (Tables 4, 5 and 6).

CONCLUSION

Shampoo evaluation tests should be conducted during and after production by regulatory agencies and researchers to assess the quality of different brands. In this study 47 shampoo samples were evaluated in terms of their pH levels, percentage of inorganic matter, moisture content, dirt dispersion, foaming ability, foaming stability and microbiological determination. The results obtained were compared with PSQCA standards. The results indicated that almost all the tested shampoos meet the requirements of the PSQCA standards, which means they are chemically safe and sound. However, slight variations exist between brands due to manufacturing processes, laboratory conditions, and other factors. Determining the best shampoo among those tested is challenging

Table 4. *Determination of Microbiological Contaiminants in Keratin Based Shampoos*

Company Name	Total Plate Count/g	*Staphylococcus aureus*/g	*E. coli* (MPN/g)	*Salmonella spp.* /25g
Loreal Paris elvive dream long straight keratin shampoo	White creamy colour	None	5.8±0.1	5.65±0.01
Vince Biotin and keratin Shampoo	White colour	Light	6.0±0.1	4.62±0.01
Nutrafix keratin Shampoo	Light brown colour	Moderate	6.4±0.1	5.63±0.01
Vince Intense keratin Shampoo	White colour	Light	6.8±0.1	4.66±0.01
Set and touch keratin Repair Shampoo and conditioner	Creamy white colour	None	4.8±0.1	4.89±0.01
Ottlay keratin Care shampoo	White colour	Moderate	7.1±0.1	5.08±0.01
Eazicare keratin complex shampoo	Light blue colour	None	5.1±0.1	5.53±0.01
Deluxe keratin premium enrichment shampoo	Creamy white colour	None	7.7±0.1	6.11±0.01
Tresemme keratin smooth shampoo	White colour	None	4.3±0.1	3.72±0.01

ND=Not Detected

Table 5. *Determination of Microbiological Contamination in Dye Lock Shampoo*

Company Name	Total Plate Count/g	*Staphylococcus aureus*/g	*E. coli* (MPN/g)	*Salmonella spp.* /25g	Inorganic Matter %
Loreal paris Elvive colour protect	<10	ND*	ND	ND	4.56±0.01
Tresemme keratin smooth colour shampoo	<10	ND	ND	ND	3.67±0.01
Eazicare colour lock shampoo	<10	ND	ND	ND	1.29±0.01
Herbal Essences Color Me Happy	<10	ND	ND	ND	5.12±0.01
Tresemme color revitalize shampoo	<10	ND	ND	ND	3.87±0.01
Pantene Pro-V Brunette Expressions Shampoo	<10	ND	ND	ND	4.43±0.01
Pureology Pure Volume Shampoo	<10	ND	ND	ND	5.19±0.01
Pantene Pro-V Color Hair Solutions	<10	ND	ND	ND	6.21±0.01
Yardlie hair colour shampoo	<10	ND	ND	ND	5.90±0.01

ND=Not Detected.

Table 6. *Determination of Microbiological Contamination in General Purpose Shampoos*

Company Name	Total Plate Count/g	*Staphylococcus aureus*/g	*E. coli* (MPN/g)	*Salmonella spp.*/25 g
Aarch Amla shampoo	2.1×10^2	ND	ND	ND
Aarch egg shampoo	4.1×10^2	ND	ND	ND
Heads and shoulder antidandruff shampoo	<10	ND	ND	ND
Heads and shoulder classic clean shampoo	<10	ND	ND	ND
Loreal paris total repair 5 shampoo	<10	ND	ND	ND
Argan Deluxe professionals Argan Oil Nourishing shampoo	<10	ND	ND	ND
Adore egg shampoo	3.5×10^2	ND	ND	ND
Herbal infusion hair growth shampoo	<10	ND	ND	ND
Wellie professional onion anti hair loss shampoo	<10	ND	ND	ND
Dove silky and straight shampoo	<10	ND	ND	ND
Lifebuoy shampoo strong and shiny	3.2×10^2	ND	ND	ND
Lifebuoy herbal shampoo	2.2×10^2	ND	ND	ND
Sunsilk black shine shampoo	<10	ND	ND	ND
Sunsilk hair fall shampoo	<10	ND	ND	ND
Tresemmne clean and replenish shampoo	<10	ND	ND	ND
Johnson's baby shampoo	<10	ND	ND	ND
Berg amla shampoo silky and strong	1.1×10^2	ND	ND	ND
Olina Kalonji Amla Shampoo	2.5×10^2	ND	ND	ND
Samsol egg shampoo	3.3×10^2	ND	ND	ND
Hello hair anti dandruff shampoo and conditioner	<10	ND	ND	ND
Hello hair egg protein shampoo and conditioner	<10	ND	ND	ND
Hello hair daily moisturizing shampoo and conditioner	<10	ND	ND	ND
Hello hair herbal shampoo conditioner	<10	ND	ND	ND
Set and touch rich black shine shampoo and conditioner	<10	ND	ND	ND
Set and touch long and strong shampoo and conditioner	<10	ND	ND	ND
Set and touch hairfall solution shampoo	<10	ND	ND	ND
Herbal essence shampoo	<10	ND	ND	ND
Bio amla herbal shampoo	3.4×10^2	ND	ND	ND
Bio black shine shampoo	<10	ND	ND	ND

because no single formulation performed consistently better than others in all tests. Additionally, ranking the tests by importance is difficult since each test holds its own significance. Although some shampoos exhibited characteristics outside the standard range, most of them met the expected standards. In conclusion, the tested shampoos can be considered as viable alternatives to one another since they produced comparable results across different tests.

INSTITUTIONAL BOARD PERMISSION

Not applicable.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

1. Minamoto K. Skin sensitizers in cosmetics and skin care products. *Nihon Eiseigaku Zasshi*. 2010; 65(1): 20-29. doi: 10.1265/jjh.65.20

2. Dureja H, Kaushik D, Gupta M, Kumar V, Lather V. Cosmeceuticals: An emerging concept. *Indian Journal of Pharmacology*. 2005; 37(3): 155. doi: 10.4103/0253-7613.16211

3. Patravale V, Mandawgade S. Novel cosmetic delivery systems: An application update. *International journal of cosmetic science*. 2008; 30(1): 19-33. doi: 10.1111/j.1468-2494.2008.00416.x

4. PAKISTAN STANDARDS FOR SHAMPOO. PS: 3509-1994 _ UDC: - 668.585. http://www.puntofocal.gob.ar/notific_otros_miembros/pak85_t.pdf. Accessed

5. Sharma RM, Shah K, Patel J. Evaluation of prepared herbal shampoo formulations and to compare formulated shampoo with marketed shampoos. *Int J Pharm Pharm Sci*. 2011; 3(4): 402-405.

6. Bisht LK, Jacob B, Chandy V. Evaluation studies on various reputed brands of shampoo. *Asian J Appl Sci Technol*. 2017; 1(6): 23-25.

7. Trüeb RM. Shampoos: Ingredients, efficacy and adverse effects. *J Dtsch Dermatol Ges*. 2007; 5(5): 356-365. doi: 10.1111/j.1610-

0387.2007.06304.x

8. Gubitosa J, Rizzi V, Fini P, Cosma P. Hair care cosmetics: From traditional shampoo to solid clay and herbal shampoo, a review. *Cosmetics*. 2019; 6(1): 13. doi: 10.3390/cosmetics6010013

9. AlQuadeib BT, Eltahir EK, Banafa RA, Al-Hadhairi LA. Pharmaceutical evaluation of different shampoo brands in local Saudi market. *Saudi Pharm J.* 2018; 26(1): 98-106. doi: 10.1016/j.jsps.2017.10.006

10. Cornwell P. A review of shampoo surfactant technology: Consumer benefits, raw materials and recent developments. *Int J Cosmet Sci.* 2018; 40(1): 16-30. doi: 10.1111/ics.12439

11. Patil A, Sandewicz RW. Cosmetic science and polymer chemistry: Perfect together. In: *Polymers for Personal Care and Cosmetics*. Washington, D.C., USA: ACS Publications; 2013: 13-37. doi: 10.1021/bk-2013-1148.ch002

12. Arora P, Nanda A, Karan M. Shampoos based on synthetic ingredients vis-a-vis shampoos based on herbal ingredients: A review. *International Journal of Pharmaceutical Sciences Review and Research.* 2011; 7(1): 42-46.

13. Wilkinson JB, Moore RJ. *Harry's Cosmeticology*. Harlow, Essex, England: Longman Scientific & Technical; 1983.

14. Krunali T, Dhara P, Meshram D, Mitesh P. Evaluation of standards of some selected shampoo preparation. *World J Pharm Pharm Sci.* 2013; 2(5): 3622-3630.

15. Fazlolahzadeh O, Masoudi A. Cosmetic evaluation of some Iranian commercial normal hair shampoos and comparision with new developed formulation. *International Journal of Pharmacognosy.* 2015; 2(5): 259-265.

16. Mitsui T. *New Cosmetic Science*. NL, USA: Elsevier; 1997. doi: 10.1016/B978-0-444-82654-1.X5000-5

17. Tarun J, Susan J, Suria J, Susan VJ, Criton S. Evaluation of pH of Bathing Soaps and Shampoos for Skin and Hair Care. *Indian J Dermatol.* 2014; 59(5): 442-444. doi: 10.4103/0019-5154.139861

18. Moldovan M, Părăuan S. Cosmetic evaluation of some commercial shampoos. *Clujul Med.* 2014; 85(3): 378-383.

19. ASTM D3049-89. Standard test method for synthetic anionic ingredient by cationic titration1. 2016. doi: 10.1520/D3049-89R16

20. Deshmukh S, Kaushal B. Formulations and evaluation of herbal shampoo and comparative studies with herbal marketed shampoo. *Int. J. Pharm. Bio. Sci.* 2012; 3(3): 638-645.