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FORMULATION AND EVALUATION OF HERBAL SHAMPOOS

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ABSTRACT

Background: Now-a-days herbal Shampoo formulations are beyond the stage of pure cleaning of the hair. The critical part of herbal shampoos is their cleansing, foaming, conditioning and detergent action has important role in its acceptability. **Objective:** The objective of this study was to formulate a new herbal shampoo by utilizing the Reetha, Aloe and Henna extracts. **Materials and Methods:** Different concentrations of Reetha, Aloe and Henna used to formulate herbal shampoo. Box–Behnken statistical design was used to statistically optimize the formulation factors and evaluate main effects, interaction effects on the properties of shampoo. Formulated shampoos evaluated for organoleptic evaluation, powder characteristics, pH, dirt dispersion, detergency ability, cleaning action, foaming ability and its stability and conditioning performance. **Results:** All the formulations pH closer to the skin pH. Higher concentration of reetha shown better dirt dispersion, the shampoo containing aloe as well as reetha in higher concentration showed higher detergency, foaming and cleaning action than other formulations notably shampoo showed higher than the marketed formulation too. The formulated shampoos were uniform, denser and stable similar as that of marketed shampoo. **Conclusion:** Box-Behnken statistical evaluation of results, formulations containing 15% of Reetha, 10% - 12.5% of Aloe and 2-3% of Henna shown better performance compared with marketed formulations MF1& MF2. PS9 & PS16 formulations were selected as the best formulations based on physicochemical properties. The selected liquid shampoo has an excellent cleansing, detergency and foaming effect, is suitable for regular hair and has acceptable pH and organoleptic stability characteristics.

KEYWORDS: Aloe, Henna, Herbal Shampoo, Reetha.

INTRODUCTION

The hair follicle is a dynamic organ found in mammalian skin. It resides within the dermal layer of the skin and is formed from 20 different cell types, each have distinct functions. The follicle regulates hair growth via a superior interaction between hormones, neuropeptides and immune cells.[1] The hair papilla (Figure 1) is a bulky structure existing at the base of the hair follicle. Principally it is made up of connective tissue and a capillary loop. Hair matrix is existing nearby the papilla. A root sheath include of an external and internal fragments. The external root sheath seems empty with cuboid cells when stained haematoxylin and eosin stain. The internal root sheath is composed of three layers, Henle's layer, Huxley's layer, and an internal cuticle that is continuous with the outermost layer of the hair fiber.[2] The sebaceous gland, which secretes the oily or waxy substance called as sebum. The higher the density of the hair the more will be the sebaceous glands. Sebum protect the skin against friction and helps it to become more resistant to moisture.[3,4] Amongst all mammals, humans have the longest growth phase of scalp hair compared to hair growth on other parts of the body.[5] For centuries, humans have ascribed aesthetics to scalp hair styling and dressing, and it's often habituated to communicate social, or cultural norms in societies. In addition to its role in defining human appearance, scalp hair also provides protection from UV sun rays and is an insulator against extremes of hot and cold temperatures.[1] Differences within the shape of the scalp follicle determine the observed ethnic differences in scalp hair appearance, length and texture.

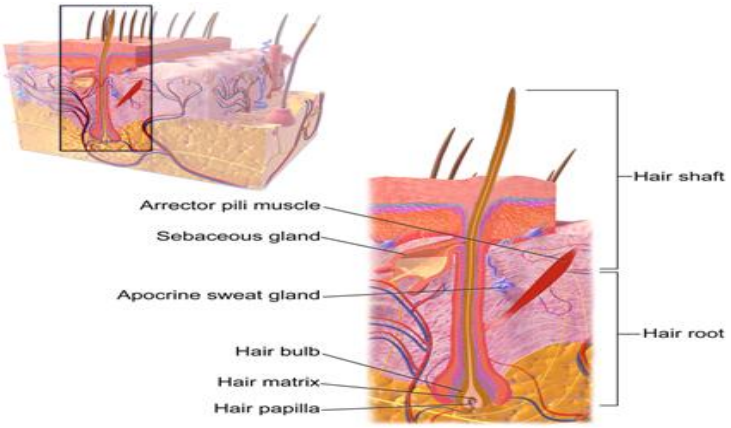

Figure 1: Structure of hair follicles.

Hair grows in cycles of various phases: anagen is the evolution phase; catagen is the involution phase; and telogen, the inactive or dormant phase (phase names derived consuming the Greek prefixes ana-, kata-, and telos- meaning up, down, and end, respectively). Each phase has several morphologically and histologically different sub-phases. Aforementioned to the start of cycling is a stage of follicular morphogenesis (formation of the follicle). There is also a shedding phase, or exogen, that's independent of anagen and telogen within which one or several hairs which may rise from a lone follicle exits. Normally up to 90% of the hair follicles are in anagen phase, while 10 –14% are in telogen and 1–2% in catagen.[6]

There are numerous human diseases which causes abnormalities in hair exterior, texture or growth, which are initial marks of local disease of the hair follicle or systemic illness. Hair Damage is disorder whereby one or more of the hair structures (cuticles, cortex, medulla, etc.), are physically or chemically altered to the amount that they are incapable to reoccurrence to their original state. Cuticles were designed by nature to guard the gentle inner structures of the hair, to retain moisture and reflect light. They are arranged like moderately overlying roof pebbles, while on healthy hair, they are very tightly aligned. Upon damage cuticles can developed fractured and tattered. Some of the keratin material, (of which cuticles are composed), can soften and disintegrate, making the hair shaft thinner. In severe cases, entire portions of the cuticle layer can be detached completely.

Longitudinal Rupturing will happen on extreme damage, the hair shaft experiences an enormous crack along its length and can lead to injury to the cortex and medulla. The disagreement leaves the hair fiber exposed and unguarded. Fibril Disintegration cause excessive damage, the strong proteinaceous fibers of the cortex gets damaged and frequently disintegrate. The fibers disagreement give the hair shaft an untidy, unbalanced alignment.[7,8,9]

There are multiple Evidences of Hair Damage includes Loss of Elasticity & tensile strength, Breakage, Porosity & moisture loss, Dullness, Brittleness, splitting, Excessive tangling and Limpness.

Hair damage mainly occurs due to ultraviolet exposures, mechanical manipulations, chemical processing, thermal styling and usage different of shampoos containing high pH and strong detergent.

Shampoos are probably the most widely used cosmetic products for cleansing hairs and scalp in our daily life.[10] A shampoo is basically a solution of a detergent containing suitable additives for other benefits such as hair-conditioning enhancement, lubrication, medication etc. Now-a-days many synthetic, herbal, medicated and non-medicated shampoos are available in the market but popularity of herbal shampoo among consumers is on rise because of their belief that these products being of natural origin are safe and free from side effects.[11] Synthetic surfactants are added to shampoo primarily for the foaming and cleansing action but their regular use leads to dryness of hairs, hair loss, irritation to scalp and eyes.[12] Herbal formulations are considered as alternative to synthetic shampoo but formulating cosmetics using completely natural raw material is a difficult task.[13] There are large numbers of medicinal plants which are reported to have beneficial effects on hair and are commonly used in formulation of shampoo.[14] These plant products may be used in their powdered form, crude form, purified extracts, or derivative form. [15] It is extremely difficult to prepare a herbal shampoo using a single natural material that would be milder and safer than the synthetic ones, and at the same time would compete favourably with its foaming, detergency and solid content. We, therefore, considered to formulate a pure herbal shampoo using traditionally and commonly used plant materials for hair washing.

The pericarp of Spindus mukorossi, commonly known as Soap nut or reetha, which produces rich later when shaken with water due to their high content of saponins. Reetha, Aloe and Henna extracts used in the herbal shampoo formulation preparation.

This study was designed to formulate a herbal shampoo and to evaluate and compare its physicochemical properties with the marketed synthetic and herbal shampoo in search of a safe and effective cosmetic product.

MATERIALS AND METHODS

Reetha, Aloe and Henna extracts procured from local market (Visakhapatnam) and all other ingredients used in this study are either analytical grade or pharmaceutical grade.

Preparation of powder herbal shampoo

Weighed quantity of extracts were passed through 60-mesh sieve individually and collected. The quantity of Reetha, Aloe and Henna were mixed in different portions based on statistical design and blended to get a uniform mixture and evaluated. The study range of different compositions of natural shampoos are between 5% to 15% of Reetha; 7.5% to 12.5% of Aloe and 2% to 4% of Henna concentrations. The powdered shampoos were mixed with water to attain 10 to 20% solid content in the dispersed form.

Design-Expert® software was employed for statistical analysis and graph plotting. The effect of independent variables on the responses was calculated by ANOVA. The *P*-value less than 0.05 was considered to be statistically significant.

Box–Behnken statistical design was used to statistically optimize the formulation factors and evaluate main effects, interaction effects on the properties of shampoo. A 3-factor, 3-level Box –Behnken design was used to explore quadratic response surfaces and constructing second-order polynomial models with Design Expert® (Version 12.0, Stat-Ease Inc., Minneapolis, MN). The Box–Behnken design was specifically selected since it requires fewer runs than a central composite design (CCD) in cases of three or four variables. This cubic design is characterized by set of points lying at the midpoint of each edge and centre point of the multidimensional cube. A design matrix comprising of 17 experimental runs was constructed. The non-linear computer generated quadratic model is given as β1

$$Y = B0 + B1A + B2B + B3C + B4AB + B5AC + B6BC + B7\,A2 + B8\,B2 + B9\,C2$$

Where, Y is the measured response associated with each factor level combination;

B0 is an intercept;

B1 to B3 are linear coefficients,

B4 to B6 are the interaction coefficients and

B8 to B9 are the squared coefficient computed from the observed experimental values of Y; and A, B, and C are the coded levels of independent variables. The dependent and independent variables selected along with their low, medium and high levels, which were selected to prepare the 17 experimental trials and the respective observed responses (Table 1 & 2).

Table 1: Three level Box- Behnken design to study different ratios of extracts used for manufacturing of herbal shampoos.

Factors: Process variables		***Levels***		
		-1	***0***	***+1***
A	Reetha (% w/w)	5	10	15
B	Aloe (% w/w)	7.5	10	12.5
C	Henna (% w/w)	2	3	4
Responses		***Target***		
Y1	Detergency (%)	70 -100		
Y2	Cleaning (%)	3.5 – 7.5		
Y3	Foaming (%)	30 - 42		
Y4	pH	3 - 4		
Y5	Dirt dispersion	Light, Moderate and None		

Table 2: Experimental runs details.

Formulation	***A: Reetha***	***B: Aloe***	***C: Henna***
	% w/w	***% w/w***	***% w/w***
PS1	10	7.5	4
PS2	15	10	4
PS3	10	10	3
PS4	10	12.5	4
PS5	10	10	3
PS6	10	12.5	2
PS7	10	10	3
PS8	10	10	3
PS9	15	10	2
PS10	5	10	4
PS11	10	7.5	2
PS12	5	7.5	3

PS13	15	7.5	3
PS14	5	12.5	3
PS15	10	10	3
PS16	15	12.5	3
PS17	5	10	2

Herbal shampoo evaluation

Upon preparation of the Herbal shampoos as per the DoE trial runs; the evaluation of herbal shampoos was done for powders (i.e. before mixing with water) for organoleptic and general powder characteristics evaluation. And for herbal shampoos (i.e. mixing the powder with water) physicochemical properties evaluated and the details are given below

Organoleptic evaluation

Organoleptic evaluation of the parameters like colour, odour and texture was carried out. Colour and texture were evaluated by vision and touch sensation respectively. For odour evaluation, a team of five odour sensitive persons was formed and random sampling was performed.

General powder characteristics

General powder characteristics include evaluation of the parameters which effect on the external properties (like flow properties, appearance, packaging criteria etc.) of the preparation, Characteristics evaluated under this section were of powder characteristics, particle size, angle of repose and density.

Physico-chemical evaluation

Determination of pH

The pH of 10% shampoo solution in distilled water was determined at room temperature 25°C.

Dirt dispersion

Two drops of shampoo were added in a test tube containing 10 ml of distilled water. 1 drop of Indian ink was added and the test tube was enclosed and shaken for ten times. The amount of ink in the foam was estimated as None, Light, Moderate, or Heavy.

Cleaning action

The 0.5 gm of hair crumple was added into a mixture of 5 gm soil and 0.5 gm of acacia with 5 ml of water. The soiled hair washed with the water containing 1gm of shampoo then dried. The weight of dried hair was noted and considered as test weight. The hair crumple washed with water without shampoo was considered as control,

$CP = 100(1-T/C)$ ……*Eq. 1.*

Where,

CP is the percentage of cleaning action;

C is the weight of hairs without shampoo;

T is the weight of hairs after shampoo

Detergency ability

The Thompson method was used to evaluate the detergency ability of the samples. Briefly, a swatch of hair were washed with a 5% sodium lauryl Sulfate (SLS) solution, dried and divided into 3 gm weight groups. The samples were suspended in a n-hexane solution containing 10% artificial sebum and the mixture was shaken for 15 minutes at room temperature. Then samples were removed, the solvent was evaporated at room temperature and their sebum content determined. In the next step, each sample was divided into two equal parts, one washed with 0.1 ml of the 10% test shampoo and the other considered as the negative control. After drying, the resided sebum on samples was extracted with 20 ml n-hexane and re-weighed. Finally, the percentage of detergency power was calculated using the equation mentioned below

$DP = 100\ (1-T/C)$ ……*Eq. 2*

Where,

DP is the percentage of detergency power;

C is the weight of sebum in the control sample and

T is the weight of sebum in the test sample.

Foaming ability and foam stability

It was calculated using cylinder shake method 50 ml of 1% shampoo solution was taken in a 250 ml graduated cylinder and covered with hand and shaken for 10 times. The total volumes of the foam contents after 1 minute shaking was recorded. The foam volume was calculated immediately after shaking the volume of foam at 1 minute intervals up to 4 minute to check the stability.

Evaluation of conditioning performance

A hair tress of a woman was obtained from a local salon. It was cut into four swatches of the tresses with approximately length of 10 cm and the weight of 5 g. A swatch without washing served as the control. Other three tresses were washed with the commercial and formulated shampoos in an identical manner. For each cycle, each tress was shaken with the mixture of 10 g of a sample and 15 g of water in a conical flask for 2 min and then rinsed with 50 ml water. Afterward, each tress was left for air drying at room temperature. The tresses were washed for maximum ten cycles. The conditioning performance of the shampoos i.e. smoothness and softness, was evaluated by a blind touch test using twenty randomly selected volunteers. All the volunteers were blind folded and asked to touch and rate the four tresses for conditioning performance from score 1 to 4 (1 - Poor; 2 - Satisfactory; 3 - Good; 4 - Excellent).

RESULTS

Organoleptic evaluation

All the formulation showed acceptable organoleptic characteristics as shown in Table 3.

Table 3: Organoleptic evaluation.

S. No.	*Organoleptic evaluation*	*Result*
1	Colour	Yellowish green
2	Odour	Slight pleasant
3	Texture	Fine smooth

General powder characteristics

General powder characteristics include evaluation of the parameters which effects on the external properties (like flow properties, appearance, packaging criteria etc.) of the preparation, Characteristics evaluated under this section were of powder characteristics, particle size, angle of repose and density. All Formulations showed satisfactory and acceptable results given in table 4 - 7.

Table 4: General powder characteristics.

S. No	*Powder characteristics*	*Result*
1	Particle size	20 - 25 micro meter
2	Angle of repose	34.9°
3	Bulk density	0.340 g/mL
4	Tapped density	0.352 g/mL

Table 5: Angle of repose herbal shampoo calculation.

Method	*Height of cone (cm)*	*Radius of cone (cm)*	*tan θ = (h/r)*	*Average tan θ*	*θ = tan^{-1} (h/r)*	*Flow property*
Funnel Method	2.7 2.6 2.6	3.9 3.8 3.8	0.692 0.684 0.684	0.686	34.9	Good flow

Table 6: Bulk density calculation for herbal powder.

S. No.	*Bulk volume (ml)*	*Mass of the powder (g)*	*Bulk density (g/ml)*	*Average bulk density (g/ml)*
1	50	17.6	0.343	0.340
2	50	17.6	0.340	
3	50	17.6	0.337	

Table 7: Tapped density calculation for herbal powder.

S. No.	*Tapped volume (mL)*	*Mass of the powder (g)*	*Tapped density (g/ml)*	*Average tapped density (g/ml)*
1	45	16.2	0.352	0.352
2	46	16.2	0.352	
3	46	16.2	0.352	

Physicochemical evaluation

Physicochemical evaluation of formulated herbal shampoo evaluated for detergency, cleaning, foaming, pH and conditioning effect. The results presented in table 8.

Table 8: Evaluation of Formulation for pH, Detergency, Cleaning Action, Foaming and Dirt dispersion.

Formulation	*A: REETHA*	*B: ALOE*	*C: HENNA*	*DETERGENCY*	*CLEANING*	*FOAMING*	*pH*	*Dirt dispersion*
	%	*%*	*%*	*%*	*%*	*%*		
PS1	10	7.5	4	70.05	6.25	37.46	3.45	None
PS2	15	10	4	96	6.1	38.66	3.5	None
PS3	10	10	3	84.01	5.4	36.2	3.3	Light
PS4	10	12.5	4	88.45	7.01	40.43	3.29	Light
PS5	10	10	3	86	5.73	35.3	3.34	Light
PS6	10	12.5	2	97	3.98	37.6	3.65	Light
PS7	10	10	3	98	5.4	35.52	3.42	Light
PS8	10	10	3	84.34	5.5	35	3.49	Light
PS9	15	10	2	97.65	5.4	40.6	3.45	None
PS10	5	10	4	70.7	6.48	40.89	3.30	Light
PS11	10	7.5	2	79.67	6	39.24	3.61	Light
PS12	5	7.5	3	65.66	4.7	36.69	3.38	Light
PS13	15	7.5	3	82.2	4.38	33.15	3.41	None

PS14	5	12.5	3	96	5.45	36	3.60	Light
PS15	10	10	3	96	5.4	35.3	3.30	Light
PS16	15	12.5	3	96	3.84	41.46	3.65	None
PS17	5	10	2	80.18	4.7	38.27	3.52	Light
MF1	------	-------	-------	100	2.7	60	4.92	None
MF2	-------	-------	-------	75	4.5	65	3.18	Moderate

Determination of pH

The pH of 10% shampoo solution in distilled water was determined at room temperature 25°C. As seen from Table 8, all the formulations were of acidic pH and were ranged in between 3.18 to 3.65, which is near to the skin pH. Graphical representation presented in Figure 2.

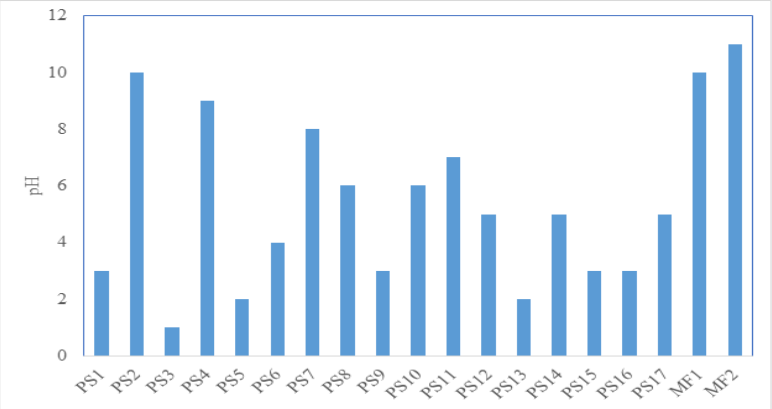

Figure 2: pH Profile of Herbal Shampoos.

Dirt dispersion

Two drops of shampoo were added in a large test tube contain 10 ml of distilled water. 1 drop of Indian ink was added; the test tube was stoppered and shaken it for ten times. The amount of ink in the foam was found to be none while in some shampoo it is light. The shampoo contains the highest concentration of Reetha shown no ink in the foam.

Detergency ability

The Thompson method was used to evaluate the detergency ability of the samples. The higher the detergency higher will be the foam. The formulations showed the detergency in the range of 70% - 98%. From the result, it was concluded that the role of Reetha and Aloe is important in detergency. Graphical representation presented in Figure 3.

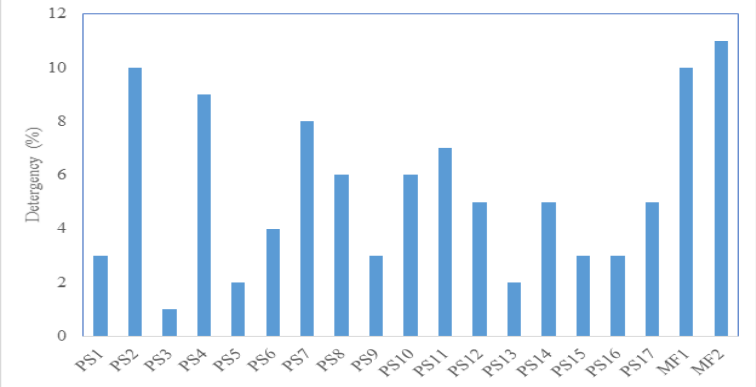

Figure 3: ***Detergency Profile of Herbal Shampoos.***

Cleaning action

The shampoo containing aloe as well as Reetha in higher concentration showed higher cleaning action than other formulations notably shampoo showed higher cleaning action than the marketed formulation too. The results of cleaning studies showed that the final formulation has significantly higher cleaning ability, when compared with the marketed formulations and it was found in between 4.38% - 7.01%. Graphical representation presented in Figure 4.

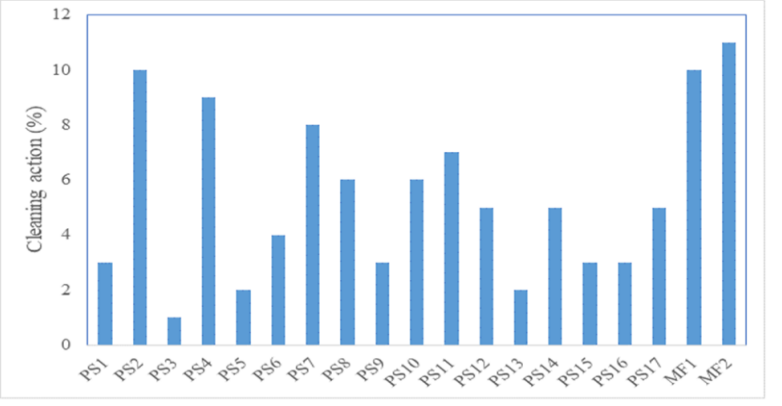

Figure 4: Cleaning Action Profile of Herbal Shampoos.

Foaming ability and foam stability

Cylinder shake method was used for determining foaming ability. The formulated formulations showed good foaming capacity, although it was less than marketed formulations, but it was found to be sufficient. PS16 formulation showed highest foaming capacity than other formulated formulations. Graphical representation presented in Figure 5.

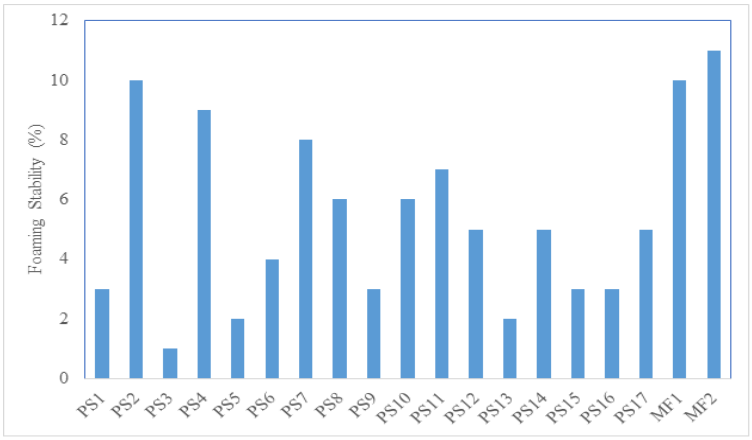

Figure 5: Foaming stability profile.

Evaluation of conditioning performance

A hair tress of an Asian woman was utilized to evaluate the conditioning performance of the shampoos i.e. smoothness and softness. It was evaluated by a blind touch test, administered to twenty randomly selected student volunteers. From the result, it was concluded that Aloe and Henna plays major role in conditioning the hairs with their maximum concentration that gives higher conditioning amongst the formulated formulations, while it was less than marketed formulation. Graphical representation presented in Figure 6.

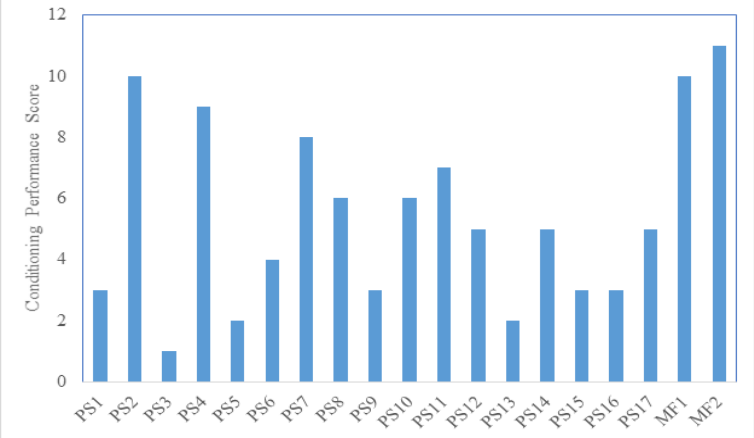

Figure 6: Conditioning performance profile of herbal shampoos.

Statistical evaluation

The experimental results for Detergency, Cleaning, Foaming and pH are presented in Table 8.

Significant factors for detergency

The Analysis of Variance (ANOVA) results are presented in Table 9.

Table 9: ANOVA results for detergency.

Source	*Sum of Squares*	*df*	*Mean Square*	*F-value*	*p-value*	*Comment*
Model	1517.57	9	168.62	4.15	0.0370	Significant
A-REETHA	439.71	1	439.71	10.82	0.0133	Significant
B-ALOE	797.40	1	797.40	19.63	0.0030	Significant
C-HENNA	107.31	1	107.31	2.64	0.1482	Not significant
AB	68.39	1	68.39	1.68	0.2356	Not significant
AC	15.33	1	15.33	0.3772	0.5585	Not significant
BC	0.2862	1	0.2862	0.0070	0.9355	Not significant
A^2	5.89	1	5.89	0.1449	0.7147	-
B^2	52.24	1	52.24	1.29	0.2941	-
C^2	23.35	1	23.35	0.5747	0.4731	-
Residual	284.41	7	40.63			-
Lack of Fit	101.04	3	33.68	0.7347	0.5835	Not significant
Pure Error	183.37	4	45.84			-
Cor Total	1801.98	16				-

As shown in the following table (Table 9), the significant factors affecting detergency were A (Reetha) and B (Aloe). The effect of Reetha (%) and Aloe (%) on detergency presented in Figure 7.

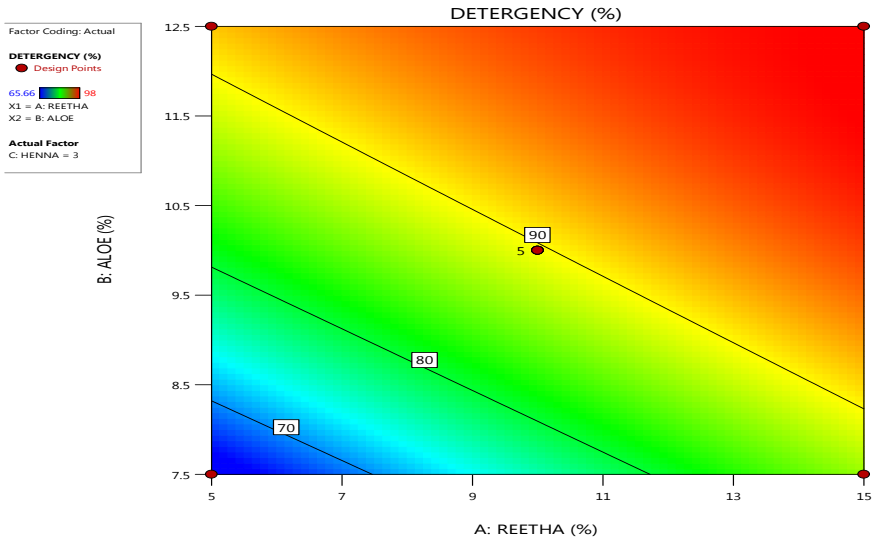

Figure 7: Effect of Reetha (%) and Aloe (%) on detergency.

Significant factors for Cleaning

The Analysis of Variance (ANOVA) results are presented in Table 10.

Table 10: ANOVA results for Cleaning

Source	*Sum of Squares*	*df*	*Mean Square*	*F-value*	*p-value*	*Comment*
Model	10.86	9	1.21	7.93	0.0062	Significant
A-REETHA	0.3240	1	0.3240	2.13	0.1878	Not significant
B-ALOE	0.1378	1	0.1378	0.9059	0.3729	Not significant
C-HENNA	4.15	1	4.15	27.26	0.0012	Significant
AB	0.4160	1	0.4160	2.73	0.1422	Not significant
AC	0.2916	1	0.2916	1.92	0.2087	Not significant
BC	1.93	1	1.93	12.70	0.0092	Significant
A^2	1.12	1	1.12	7.39	0.0298	-
B^2	0.5976	1	0.5976	3.93	0.0879	-

C^2	2.07	1	2.07	13.59	0.0078	-
Residual	1.06	7	0.1521			-
Lack of Fit	0.9829	3	0.3276	16.00	0.0108	Significant
Pure Error	0.0819	4	0.0205			-
Cor Total	11.92	16				-

As shown in Table 10, the significant factors affecting cleaning were B (Henna) and interaction of B (Aloe) and C (Henna). The effect of Henna (%) and interaction of Aloe (%) and Henna (%) on cleaning presented in Figure 8.

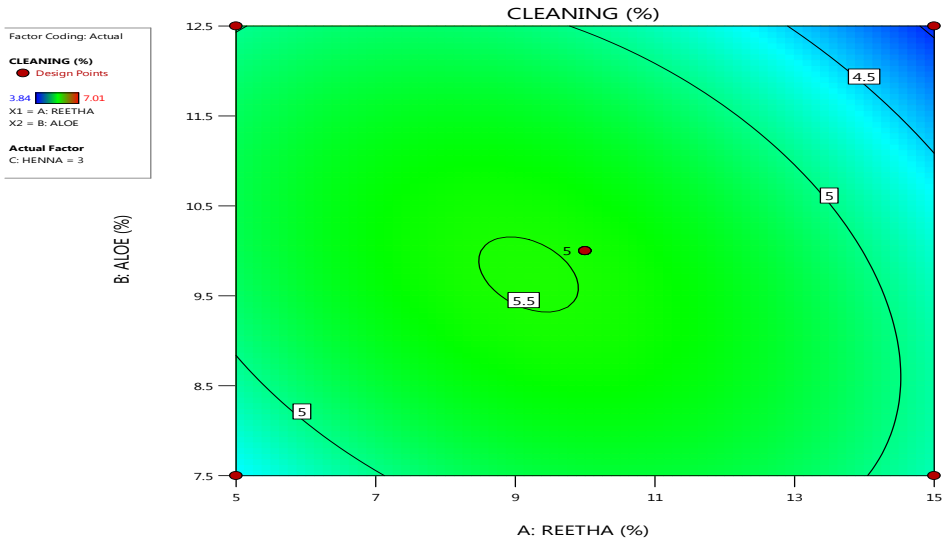

Figure 8: Effect of Aloe (%) and interaction of Aloe (%) & Henna (%) on Cleaning.

Significant factors for Foaming

The Analysis of Variance (ANOVA) results are presented in Table 11.

Table 11: ANOVA results for foaming.

Source	*Sum of Squares*	*df*	*Mean Square*	*F-value*	*p-value*	*Comment*
Model	87.52	9	9.72	11.00	0.0023	Significant
A-REETHA	0.5100	1	0.5100	0.5767	0.4724	Not significant
B-ALOE	10.01	1	10.01	11.32	0.0120	Significant
C-HENNA	0.3741	1	0.3741	0.4230	0.5362	Not significant
AB	20.25	1	20.25	22.90	0.0020	Significant
AC	5.20	1	5.20	5.88	0.0458	Significant
BC	5.31	1	5.31	6.01	0.0440	Significant
A^2	5.49	1	5.49	6.21	0.0415	-
B^2	0.2024	1	0.2024	0.2289	0.6469	-
C^2	37.88	1	37.88	42.83	0.0003	-
Residual	6.19	7	0.8844			-
Lack of Fit	5.38	3	1.79	8.81	0.0310	Significant
Pure Error	0.8139	4	0.2035			-
Cor Total	93.71	16				-

As shown in Table 11, the significant factors affecting foaming B (Aloe), interaction of AB (Reetha & Aloe), BC (Aloe & Henna) and AC (Reetha & Henna). The interactions of foaming contour plots presented in Figure 9, 10 & 11.

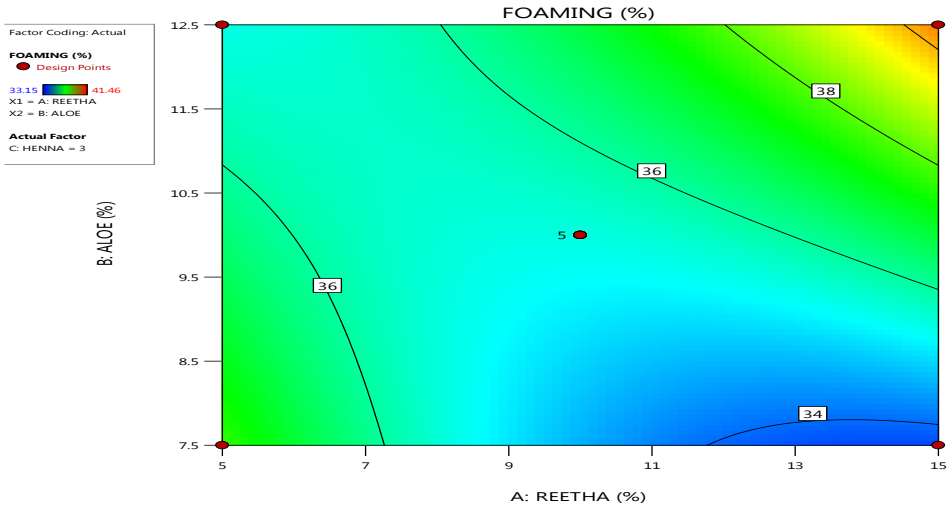

Figure 9: Effect of Aloe (%) and interaction of Aloe (%) & Henna (%) on Foaming.

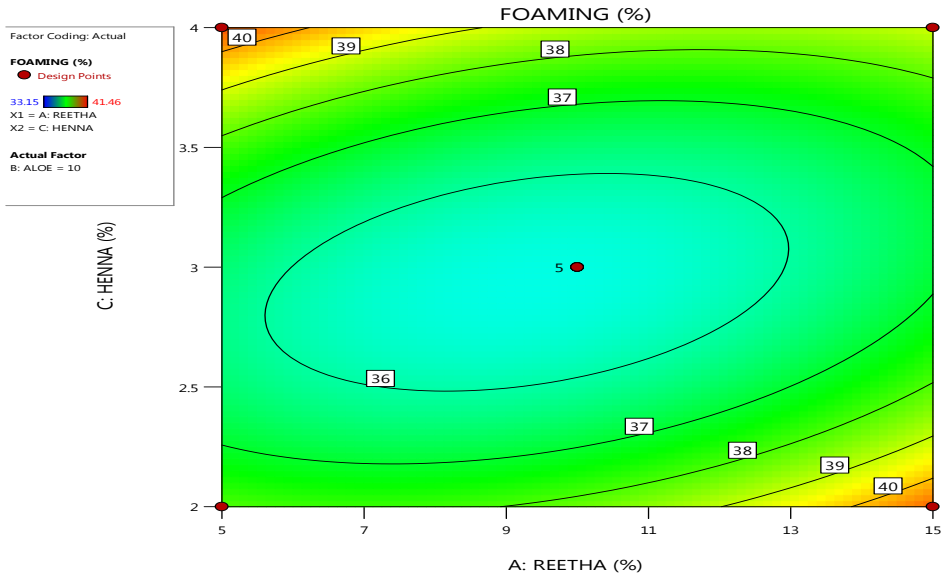

Figure 10: Effect of Reetha (%) and Henna (%) on Foaming.

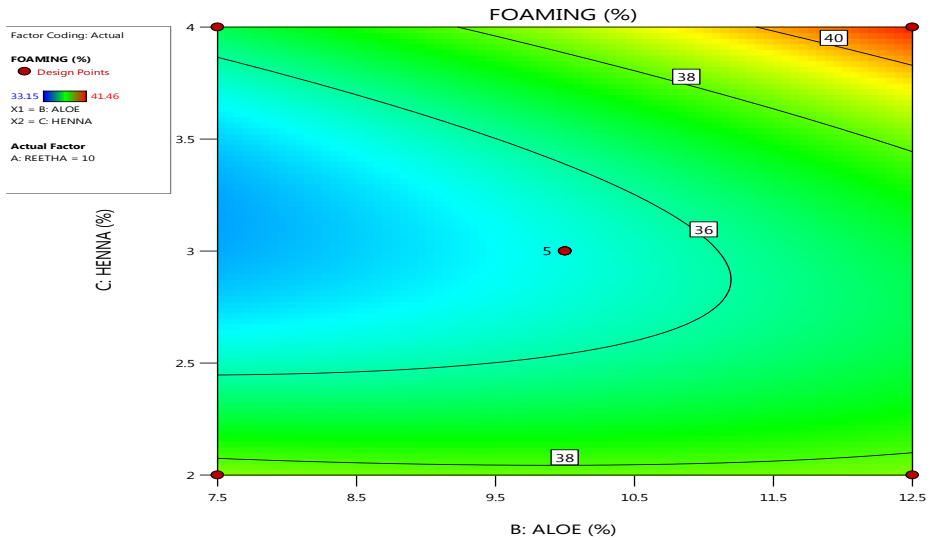

Figure 11: Effect of Aloe (%) and Henna (%) on Foaming.

Significant factors for pH

The Analysis of Variance (ANOVA) results are presented in Table 12.

Table 12: Anova results for pH.

Source	*Sum of Squares*	*df*	*Mean Square*	*F-value*	*p-value*	*Comment*
Model	0.0795	3	0.0265	2.02	0.1604	Not significant
A-REETHA	0.0055	1	0.0055	0.4210	0.5277	Not significant
B-ALOE	0.0144	1	0.0144	1.10	0.3126	Not significant
C-HENNA	0.0595	1	0.0595	4.55	0.0527	Not significant
Residual	0.1702	13	0.0131			-
Lack of Fit	0.1426	9	0.0158	2.30	0.2198	Not significant
Pure Error	0.0276	4	0.0069			-
Cor Total	0.2497	16				-

As shown in Table 12, the model itself insignificant further statistical analysis not evaluated.

DICUSSION

Organoleptic and General powder characteristics

As shown in the results, the formulations had the good characteristics with respect to organoleptic properties. It has optimum particle size, good flow, acceptable odour, colour and texture.

pH

The pH of shampoos has been shown to be important for improving and enhancing the qualities of hair, minimizing irritation to the eyes and stabilizing the ecological balance of the scalp. The current trend to promote shampoos of lower pH is one of the ways to minimize damage to the hair. Mild acidity prevents swelling and promotes tightening of the scales, thereby inducing shine. All the formulations not shown any significant variations in the pH.

Dirt dispersion

Dirt dispersion is an important criteria for evaluation of cleansing action of shampoo. Shampoos that cause the ink to concentrate in the foam are considered of poor quality because ink or dirt that stays in foam is difficult to rinse away and gets re-deposited on the hair. Therefore, the dirt should stay in the water portion for achieving better cleansing action. All shampoo concentrated the ink in the water portion, ensuring their satisfactory cleaning ability and actual effectiveness. The formulations once again proved the capacity of Reetha to clean, it showed lowest i.e. no presence of ink in the foam.

Cleaning & detergency action

Cleaning action was tested for soil. Although cleaning or soil/sebum removal is the primary aim of a shampoo, experimental dirt evaluation has been difficult to standardize, as there is no real agreement on a standard soil, a reproducible soiling process or the amount of soil that a shampoo should ideally remove. As seen from the results, there is a significant difference in the amount of sebum removed by the different shampoos. Shampoo MF1 and MF2 being a frequent-use cleanser, was expected to have the maximum detergency. Shampoos PS9 also showed highest detergency.

The herbal formulations showed higher cleaning action than other formulations.

Foaming ability and foaming stability

Foaming is very important to the consumer and therefore, it is considered as an important parameter in evaluation of shampoo. Herbal Essences and formulated shampoo produced the foam volume above up to 100 mL while marketed shampoo generated a foam volume of 95-120 mL. The foams generated by formulated shampoos were small, compact, uniform, denser and stable, similar as that of marketed shampoos.

Conditioning performance

Conditioning performance of shampoos based on the mean scores of referees is presented in Figure 6. The score of the conditioning performance of the tresses washed with formulated shampoo was found to be less conditioning effect than the marketed shampoo formulation. The results clearly indicated that the formulated shampoos are having good conditioning performance level.

Statistical evaluation

From the statistical evaluation data, higher concentration of Reetha had a significant impact on detergency. Henna and interaction of Aloe and Henna shown significant improvement in the Cleaning action. Foaming play a vital role in acceptance of herbal shampoo. Aloe shown significant impact on the foaming. Interaction of Reetha along with Aloe, Aloe along with Henna and Henna along with Reetha have significant impact.

The DOE models were used to establish acceptable ranges for formulation variables. Figure 12 shows the overlay plot of all of the responses. The Yellow zone indicates that all of the responses were achieved.

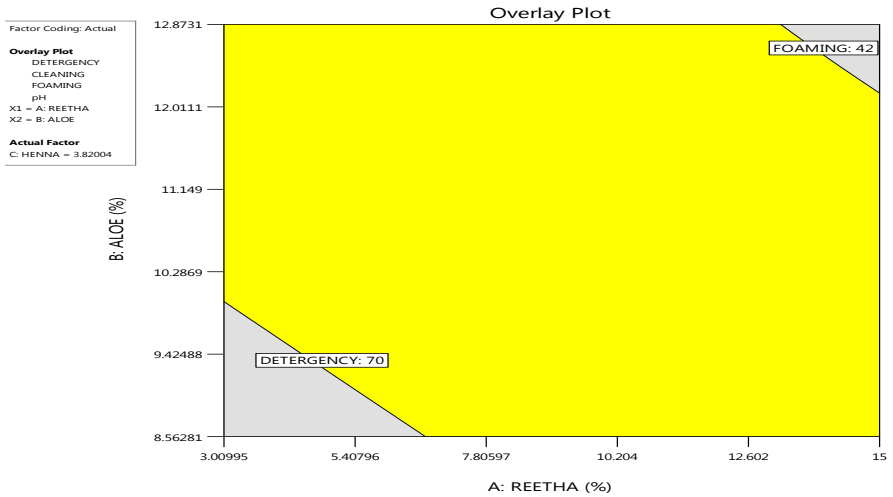

Figure 12 (a): Overlay plot – Effect of Herbal shampoo formulation variables on Reetha (%) and Aloe (%).

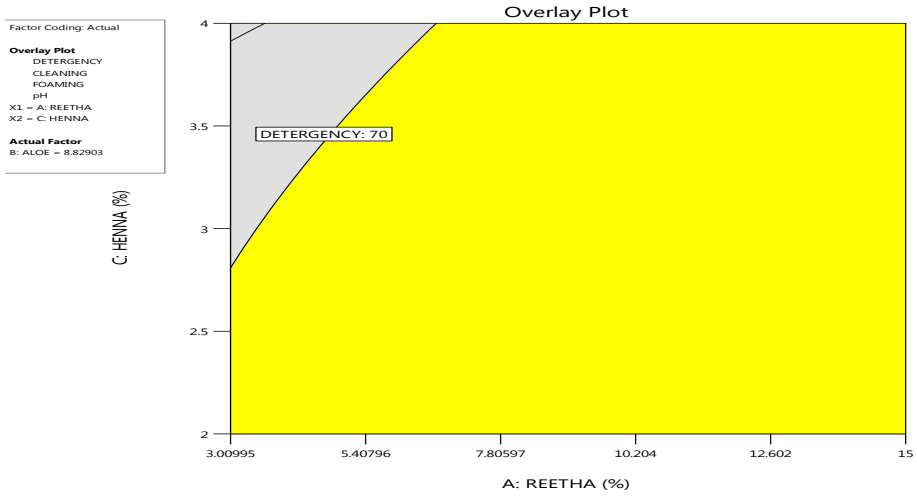

Figure 12 (b): Overlay plot – Effect of Herbal shampoo formulation variables on Reetha (%) and Henna (%).

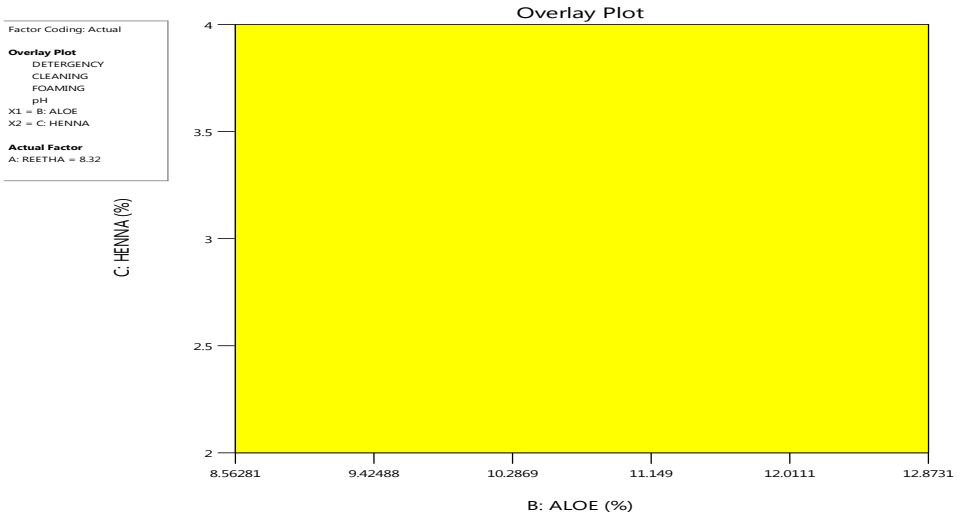

Figure 12 (c): Overlay plot – Effect of Herbal shampoo formulation variables on Aloe (%) and Henna (%).

CONCLUSION

Objective of the study was to formulate an herbal shampoo which is similar / at par with the synthetic shampoo available in the market. We formulated an herbal shampoo by using plant extracts which are commonly used traditionally and lauded for their hair cleansing actions. Reetha, Aloe and Henna shown better detergency, cleaning, Foaming and conditioning effect. PS9 and PS16 formulations shown better cleansing action compared with other formulations studied. The pH

of the shampoos formulated is closer to the skin pH. The formulated shampoos were not only safer than the chemical conditioning agents, but also greatly reduce the protein loss during combing.

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