Plant Archives
Journal home page: www.plantarchives.org
DOI Url: https://doi.org/10.51470/PLANTARCHIVES.2021.v21.no1.117

USE OF TRADITIONAL HERBS FOR THE FORMULATION OF HERBAL POWDERED SHAMPOOS AND THEIR EVALUATION

M. Madhusudhan[1]*, M. Krishnaji Rao[1], G.V. Radha[2] and S. Ganapathy[2]

[1]Divi's Laboratories Limited, Unit-2, Visakhapatnam, Andhra Pradesh, India
[2]GITAM Institute of Pharmaceutical sciences, Vishakhapatnam, Andhra Pradesh, India
*E-mail: mmsdivis@gmail.com

(Date of Receiving-08-12-2020; Date of Acceptance-20-03-2021)

ABSTRACT

The objective of the present research work is to formulate herbal shampoo using traditional herbs like Peppermint; Lemon & Hibiscus extracts as a replacement to synthetic surfactants and carryout a comparative analysis using marketed products. Herbal shampoos formulation was carried out using peppermint, Lemon & Hibiscus extract powders at different concentrations. Formulated shampoos evaluated for organoleptic evaluation, powder characteristics, pH, dirt dispersion, detergency, cleaning action, foaming ability and its stability and conditioning performance. Design Expert Statistical software used to optimize the formulations and to understand main effects, interaction effects on the properties of shampoos. All the herbal powder shampoo formulations pH closer to the skin pH. The shampoos containing higher concentration of peppermint shown higher detergency, lemon as well as peppermint showed significant effect on the foaming capacity and cleaning action and similar to marketed formulations. Higher quantity of Hibiscus concentration shown better conditioning behaviour. The formulated shampoos were uniform, denser and stable similar as that of marketed shampoo. Based on the Design expert statistical evaluation of results, formulations containing 15% of Peppermint, 1% - 3% of Lemon and 12.5% – 14.5% of Hibiscus herbal powder shampoos shown better performance compared with marketed formulations. PS19, PS20 & PS21 formulations were selected as the best formulations based on physicochemical properties. The selected herbal powder shampoos has an excellent cleansing, detergency, conditioning and foaming effect, is suitable for regular hair and has acceptable pH and organoleptic stability characteristics.

Keywords: Lemon, Hibiscus, Herbal powder Shampoo, Peppermint

INTRODUCTION

Shampoos plays a major role in the cleansing and removal of surface grease and dirt from the hair shaft and scalp. However, the foaming characteristic of shampoo plays a significant role in its acceptability (Khaloud AB *et al.,* 2014). 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 (Manikar *et al.,* 2001). 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 (Potluri *et al.,* 2013). Herbal formulations are considered as alternative to synthetic shampoo but formulating cosmetics using completely natural raw material is a difficult task(Shinde *et al.,* 2013).There are large numbers of medicinal plants which are reported to have beneficial effects on hair and are commonly used in formulation of shampoo (Firthouse *et al.,* 2009). These plant products may be used in their powdered form, crude form, purified extracts, or derivative form (Pooja *et al.,* 2011). Herbal drugs or their formulations will henceforth become an alternative to the synthetic drugs. But there is a need for formulating herbal shampoos which would have better cleaning and conditioning activity (Imran Patel *et al.,* 2016). It is extremely difficult to prepare an 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 shampoos using traditionally and commonly used plant extracts (Khaloud Al Badi *et al.,* 2014).

The objective of this study was to formulate shampoo using herbal extracts in combination at different concentrations. For this process, herbal extracts of peppermint, Lemon and Hibiscus used for shampoo preparation. Peppermint plays important role in the improve hair growth and prevent some hair loss because of its increase in the blood circulation with a vasodilator action. Lemon having acidic nature of the fruit will also tighten hair follicles, preventing hair fall and promoting healthier growth. It also improve shininess of the hair. Hibiscus can help to nourish hair and prevent split ends. It shown to be effective in reducing and controlling dandruff.

Prepared herbal powder shampoos were comparatively evaluated for organoleptic evaluation, pH, dirt dispersion, detergency ability, cleaning action, foaming ability and conditioning performance.

MATERIALS AND METHODS

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

Table 1: Experimental runs details

Formulation	A: Peppermint (%)	B: Lemon (%)	C: Hibiscus (%)
PS1	5	1	24.5
PS2	5	2	23.5
PS3	5	3	22.5
PS4	5	1	19.5
PS5	5	2	18.5
PS6	5	3	17.5
PS7	5	1	14.5
PS8	5	2	13.5
PS9	5	3	12.5
PS10	10	1	19.5
PS11	10	2	18.5
PS12	10	3	17.5
PS13	10	1	14.5
PS14	10	2	13.5
PS15	10	3	12.5
PS16	10	1	9.5
PS17	10	2	8.5
PS18	10	3	7.5
PS19	15	1	14.5
PS20	15	2	13.5
PS21	15	3	12.5
PS22	10	1	4.5
PS23	10	2	3.5
PS24	10	3	2.5

Table 2: Organoleptic evaluation

S. No.	Organoleptic evaluation	Result
1	Colour	Faint greenish
2	Odour	Slight pleasant
3	Texture	Smooth

Table 3: General powder characteristics

S No	Powder characteristics	Result
1	Particle size	18 – 25 microns
2	Angle of repose	34.4
3	Bulk density	0.353
4	Tapped density	0.388

Table 4: Angle of repose herbal shampoo calculations

S. No.	Method	Height of cone (cm)	Radius of cone (cm)	tan θ = (h/r)	Average tan θ	θ = tan-1 (h/r)	Flow property
1	Funnel Method	2.7 2.7 2.7	3.8 3.8 3.8	0.687 0.680 0.686	0.684	34.4	Good

Table 5: Tapped density calculations for herbal powder

S. No.	Tapped volume	Mass of the powder	Tapped density (g/ml)	Avg. Tapped density (g/ml)
1	43	16.2	0.376	0.388
2	40	16.2	0.405	
3	42	16.2	0.385	

Table 6: Bulk density calculation for herbal powder

Sr. No.	Bulk volume (ml)	Mass of the powder (g)	Bulk density (g/ml)	Avg. Bulk density (g/ml)
1	50	18	0.360	0.353
2	52	18	0.346	
3	51	18	0.353	

Table 7: Evaluation of Formulation for pH, Dirt Dispersion, Cleaning Action and Detergency

Formulation	A: Peppermint (%)	B: Lemon (%)	C: Hibiscus (%)	Detergecy (%)	Cleaning (%)	Foaming (%)	pH	Dirt dispersion
PS1	5	1	24.5	74	1.73	32	4.02	Light
PS2	5	2	23.5	76	1.81	34	3.91	None
PS3	5	3	22.5	72	2.8	36	3.86	Light
PS4	5	1	19.5	75	1.83	34	3.82	Light
PS5	5	2	18.5	72	1.82	36	3.75	Light
PS6	5	3	17.5	74	2.4	36	3.59	Light
PS7	5	1	14.5	72	1.70	30	3.79	Light
PS8	5	2	13.5	73	1.72	34	3.78	Light
PS9	5	3	12.5	76	2.3	34	3.66	Light
PS10	10	1	19.5	86	1.88	38	3.75	Light
PS11	10	2	18.5	82	2.8	42	3.71	Light
PS12	10	3	17.5	82	3.94	43	3.67	Light
PS13	10	1	14.5	86	1.78	38	3.85	Light
PS14	10	2	13.5	86	2.6	40	3.72	Light
PS15	10	3	12.5	84	3.74	43	3.67	Light
PS16	10	1	9.5	86	1.88	36	3.86	Light
PS17	10	2	8.5	87	2.8	39	3.8	Light
PS18	10	3	7.5	85	3.94	41	3.75	Light
PS19	15	1	14.5	95	2.33	42	3.9	Light
PS20	15	2	13.5	98	3.55	45	3.79	Light
PS21	15	3	12.5	95	3.62	48	3.7	Light
PS22	10	1	4.5	88	1.88	38	3.95	Light
PS23	10	2	3.5	85	2.8	36	3.79	Light
PS24	10	3	2.5	88	3.94	33	3.8	Light
MF1	------	-------	-------	100	2.7	60	4.92	None
MF2	-------	-------	-------	75	4.5	65	3.18	Moderate

Table 8: ANOVA results for Detergency

Source	Sum of Squares	df	Mean Square	F-value	p-value	Comment
Model	1348.09	3	449.36	161.84	< 0.0001	Significant
A-Peppermint	960.49	1	960.49	345.92	< 0.0001	Significant
B-Lemon	4.26	1	4.26	1.53	0.2301	Not significant
C-Hibiscus	14.12	1	14.12	5.09	0.0355	Significant
Residual	55.53	20	2.78			
Cor Total	1403.63	23				

As shown in the following table (Table 8), the significant factors affecting detergency were A (Peppermint) and C (Hibiscus). The effect of Peppermint (%) and Hibiscus (%) on detergency presented in Figure 6.

Table 9: ANOVA results for Cleaning

Source	Sum of Squares	df	Mean Square	F-value	p-value	Comment
Model	12.93	3	4.31	35.46	< 0.0001	significant
A-Peppermint	3.24	1	3.24	26.62	< 0.0001	significant
B-Lemon	8.16	1	8.16	67.12	< 0.0001	significant
C-Hibiscus	0.0293	1	0.0293	0.2414	0.6285	Not significant
Residual	2.43	20	0.1215			
Cor Total	15.36	23				

As shown in Table 9, the significant factors affecting cleaning were A (Peppermint) and B (Lemon). The effect of Peppermint (%) and Lemon (%) on cleaning presented in Figure 7.

Table 10: ANOVA results for Foaming

Source	Sum of Squares	df	Mean Square	F-value	p-value	Comment
Model	412.75	6	68.79	28.81	< 0.0001	significant
A-Peppermint	226.52	1	226.52	94.88	< 0.0001	significant
B-Lemon	61.10	1	61.10	25.59	< 0.0001	Significant
C-Hibiscus	45.49	1	45.49	19.06	0.0004	significant
AB	11.50	1	11.50	4.82	0.0424	Significant
AC	6.72	1	6.72	2.81	0.1117	Non-significant
BC	21.29	1	21.29	8.92	0.0083	significant
Residual	40.59	17	2.39			
Cor Total	453.33	23				

As shown in Table 10, the significant factors affecting foaming A (Peppermint), B (Lemon), C (Hibiscus), interaction of A (Peppermint) &B (Lemon) and interaction of B (Lemon) & C (Hibiscus). The interactions of foaming contour plots presented in Figure 8 & 9.

Table 11: ANOVA results for pH

Source	Sum of Squares	df	Mean Square	F-value	p-value	Comment
Model	0.1839	6	0.0306	11.47	< 0.0001	significant
A-Peppermint	0.0141	1	0.0141	5.27	0.0347	significant
B-Lemon	0.1016	1	0.1016	38.02	< 0.0001	significant
C-Hibiscus	0.0355	1	0.0355	13.30	0.0020	significant
AB	0.0046	1	0.0046	1.73	0.2053	Not significant
AC	0.0870	1	0.0870	32.57	< 0.0001	significant
BC	0.0003	1	0.0003	0.0938	0.7632	Not significant
Residual	0.0454	17	0.0027			-
Cor Total	0.2293	23				-

As shown in Table 11, the significant factors affecting pH A (Peppermint), B (Lemon), C (Hibiscus) and interaction of A (Peppermint) and C (Hibiscus). The interactions of pH contour plot presented in Figure 10.

Preparation of Powder Herbal Shampoos

Weighed quantity of extracts were passed through 60-mesh sieve individually and collected. The quantity of Peppermint, Lemon and Hibiscus were mixed in different portions based on design and blended to get a uniform mixture and evaluated. The study range of different compositions of natural shampoos are between 5% to 15% w/w of Peppermint; 1% to 3% w/w of Lemon and 2.5% to 24.5% w/w of Hibiscus concentrations. The powdered shampoos were mixed with water to attain 10 to 20% w/w solid content in the dispersed form.

Design-Expert® software was employed forstatistical evaluation and identification of optimized formulations considering physicochemical properties. It is useful for the identification of dependent and independent variables selected along with their levels. Response surface methodology was usedby constructing second-order polynomial models with Design Expert® (Version 12.0, Stat-Ease Inc., Minneapolis, MN) for analysis. 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.

The details of the 24 experimental trials and the respective details mentioned in the table 1.

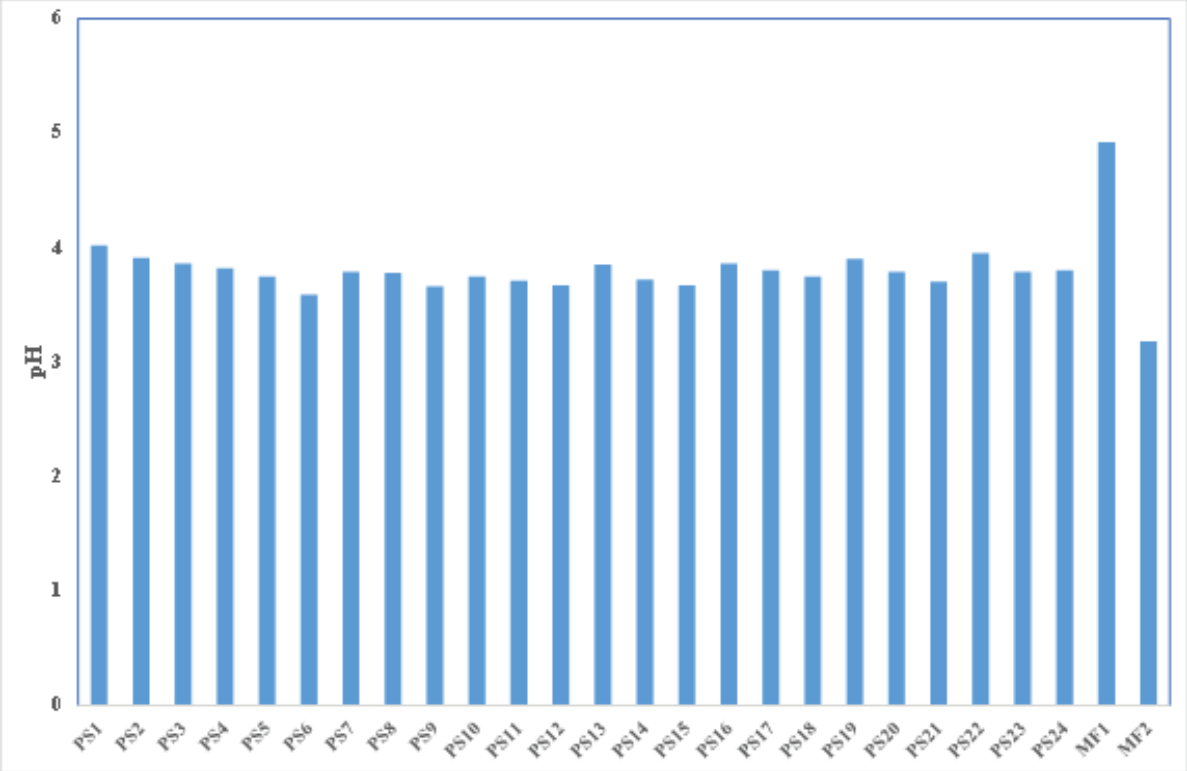

Figure 1: pH Profile of Herbal Shampoos

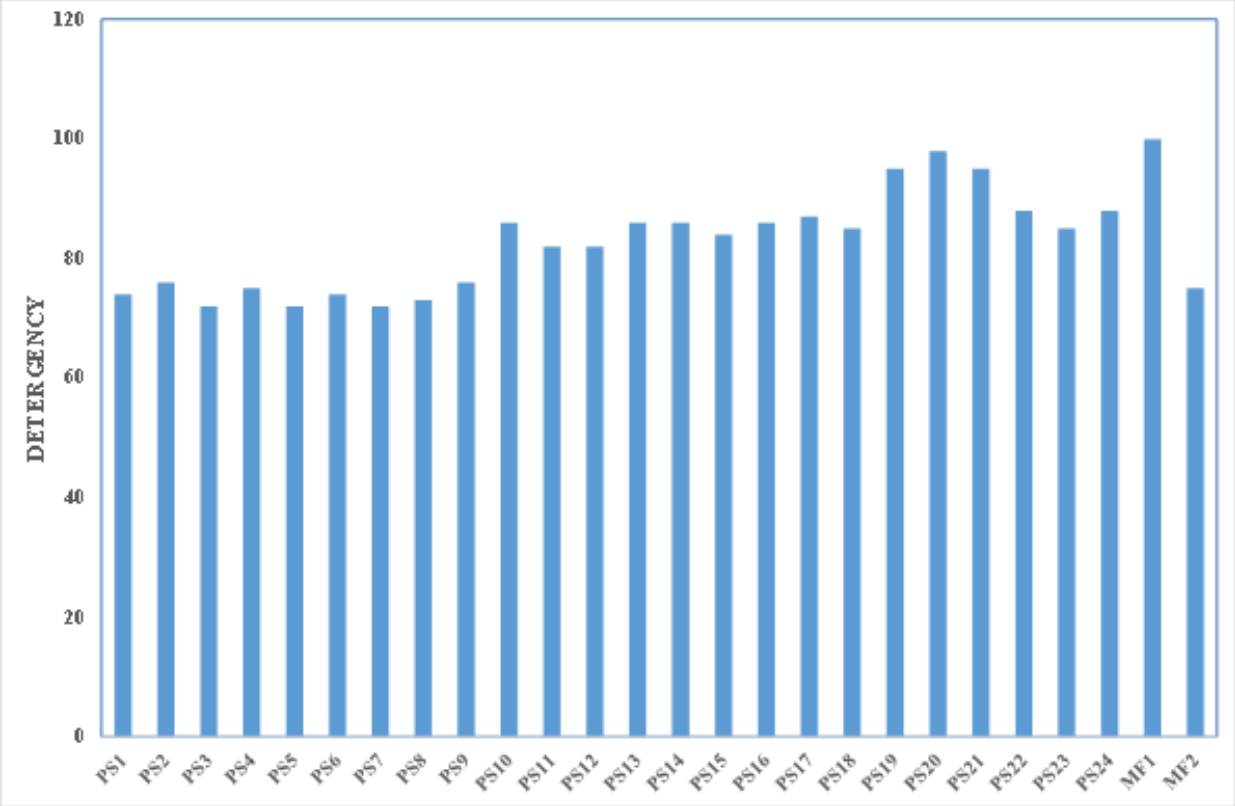

Figure 2: Detergency Profile of Herbal Shampoos

Herbal Shampoos Evaluation

Upon preparation of the Herbal shampoos as per experimental 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

Physical appearance/Visual Inspection

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 (Ashok K *et al.,* 2010).

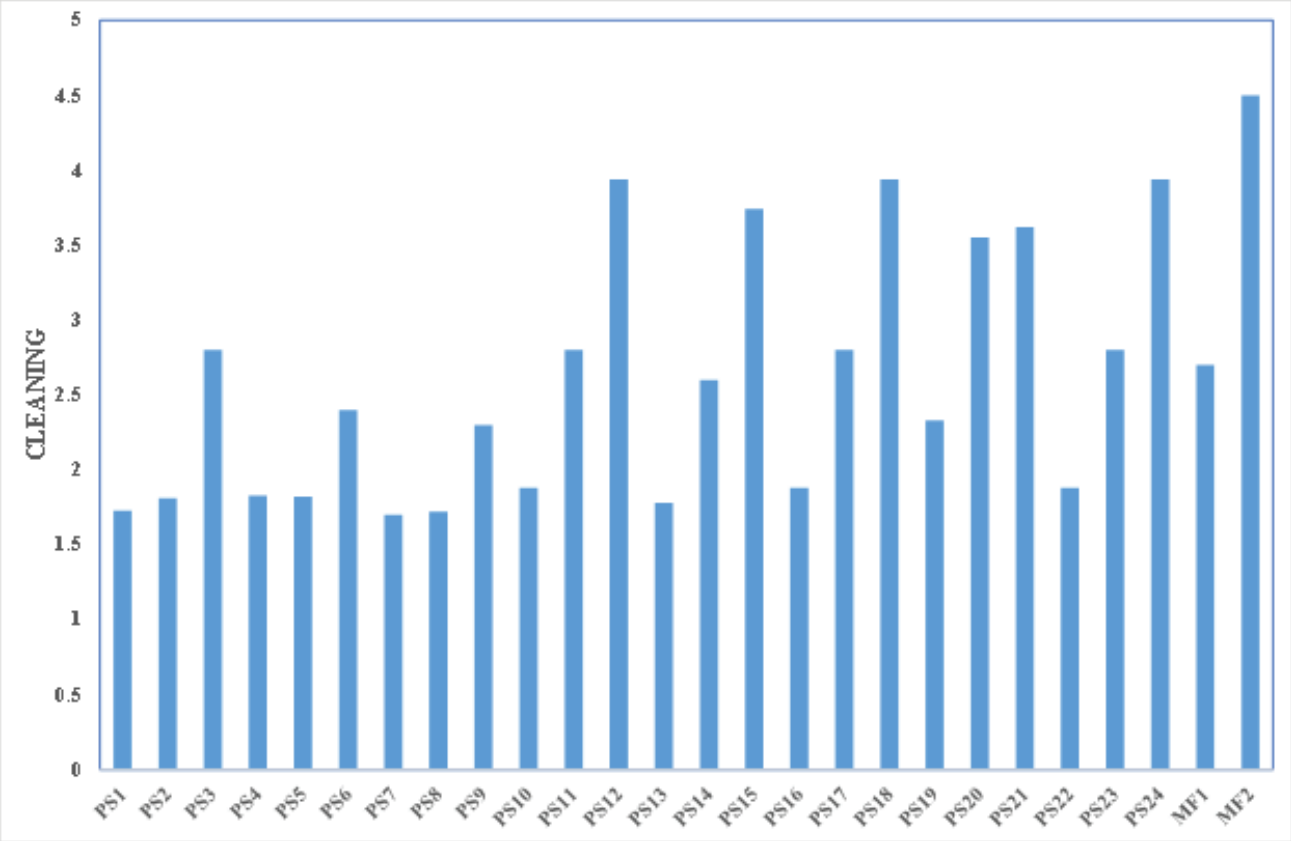

Figure 3: Cleaning Action Profile of Herbal Shampoos

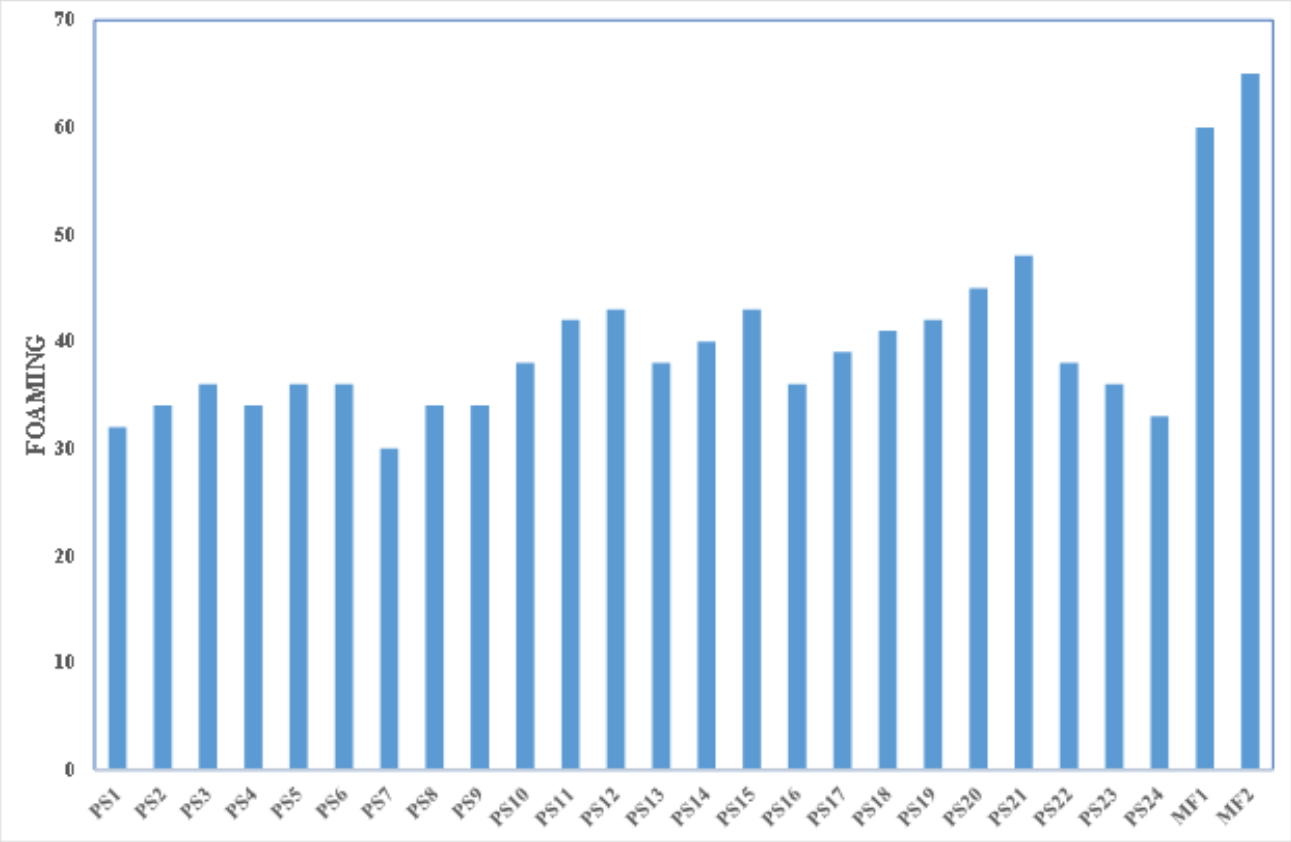

Figure 4: Foaming Stability Profile of herbal shampoos

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 and physical appearance

The pH of 10% shampoo solutions in distilled water was

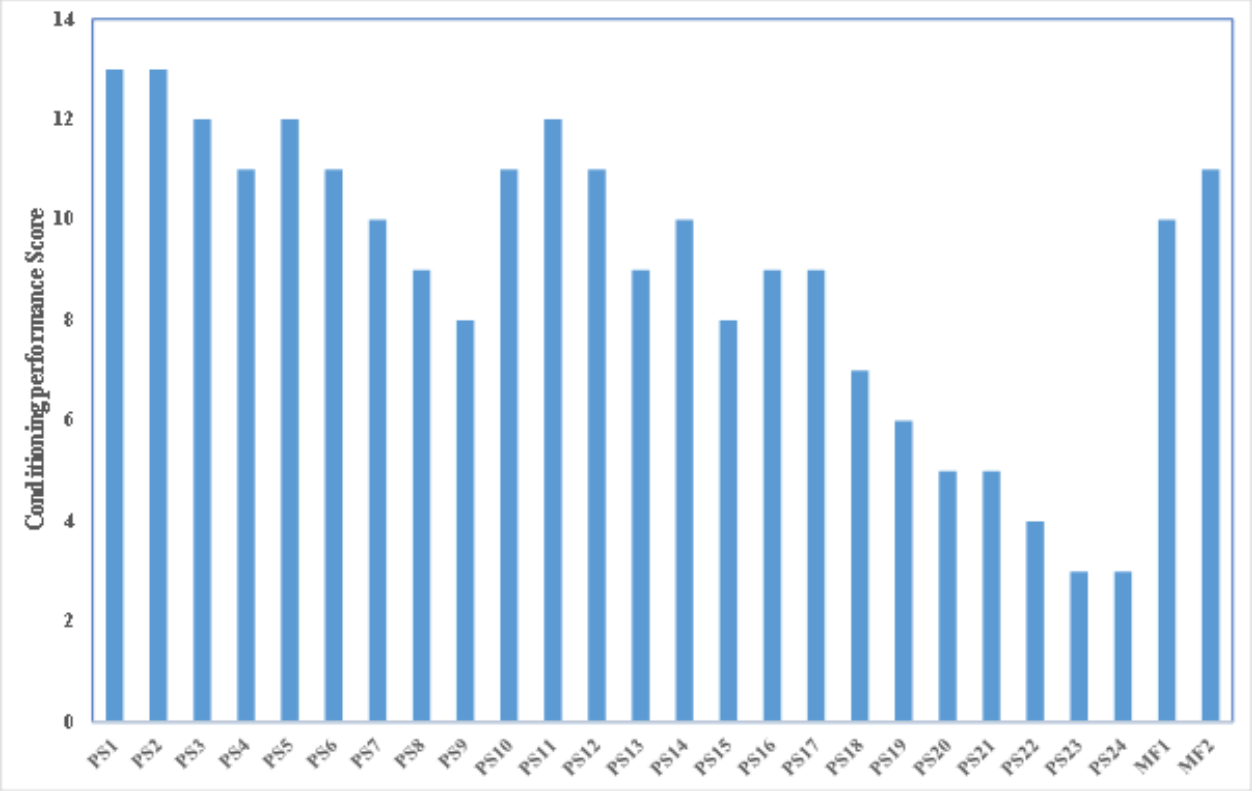

Figure 5: Conditioning Performance Profile of Herbal Shampoos

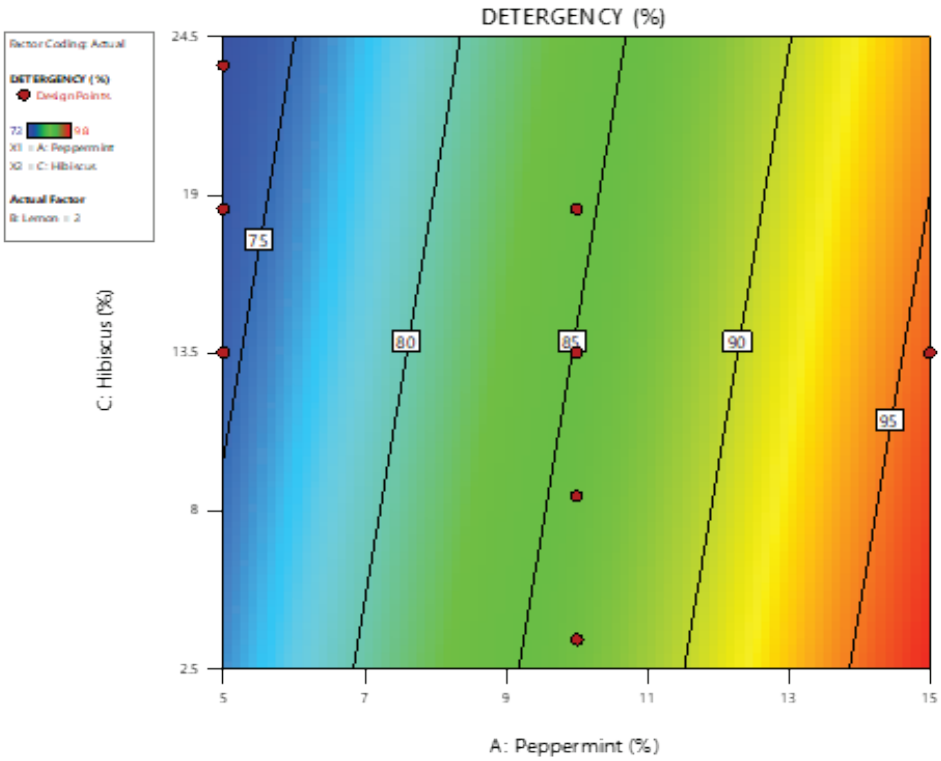

Figure 6: Effect of Peppermint (%) and Hibiscus (%) on detergency

determined at room temperature 25°C using a pH meter, and its physical appearance was noted(Tarun *et* al., 2014).

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 (Anusha P *et al.,* 2013).

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 (Rasool BK *et al.,* 2011). 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

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

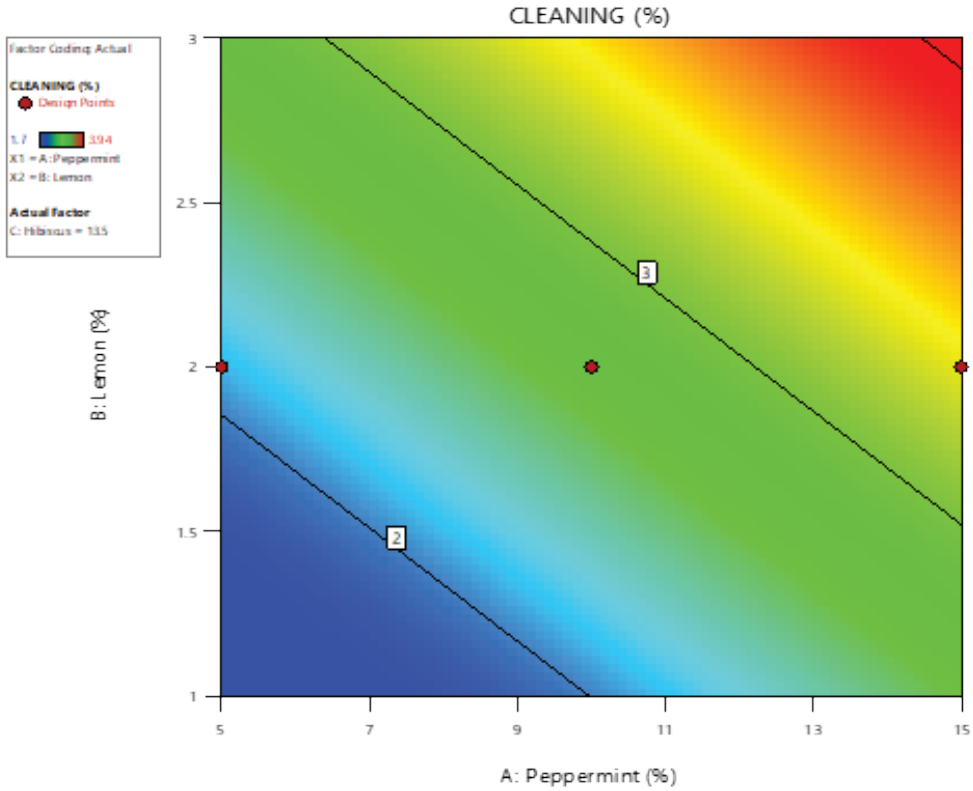

Figure 7: Effect of Peppermint (%) and Lemon (%) on Cleaning

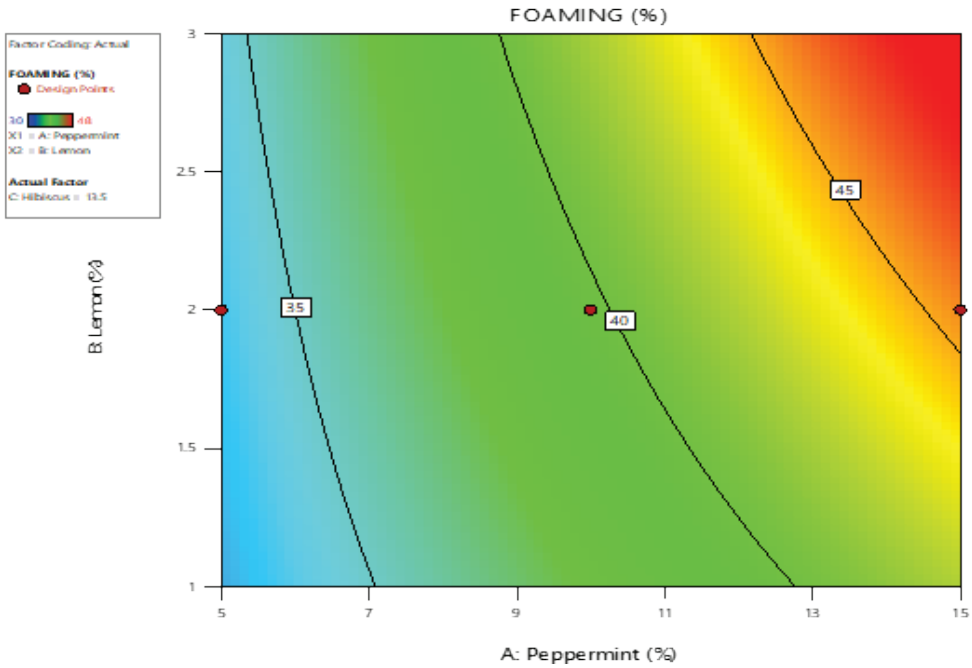

Figure 8: Effect of Peppermint (%) and Lemon (%) on Foaming

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 (Shinde PR., 2013)

$$DP = 100\ (1\text{-}T/C) \qquad Eq.\ 2$$

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

Cylinder shake method was used for determining foaming ability. 50 ml of 1 % shampoo solutions were taken in a 250 mlgraduated 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 (Nasrin A *et al.,* 2007).

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 (Boonme *et* al., 2011). 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 AND DISCUSSION

With the help of herbal extracts, an herbal powdered shampoos were formulated by mixing different constituents in specific proportions. Selected plant materials are rich in polyphenol compounds such as a flavonoid, phenolic and saponin. They have found to exhibit cleansing and surfactant properties. These herbal extracts also provided viscosity to the formulations. Physicochemical properties of the herbal powdered shampoos were statistically evaluated using Design – Expert Software to select optimized formulations. The formulations were analysed during the initial month of preparation and after the third month to check their stability and found results satisfactory.

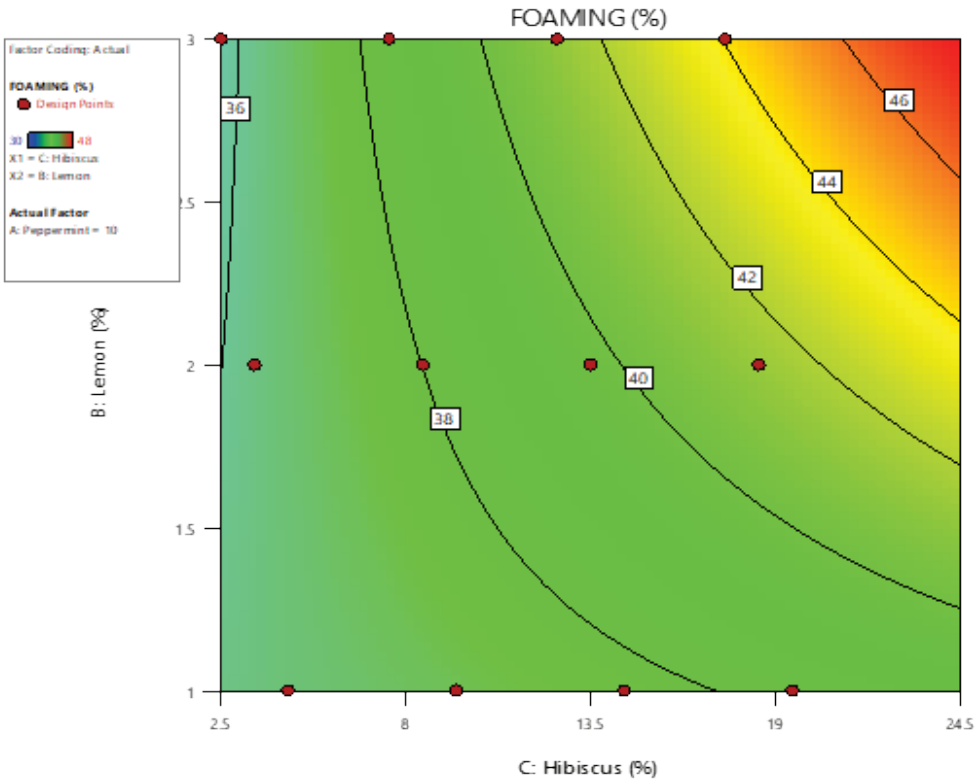

Figure 9: Effect of Lemon (%) and Hibiscus (%) on Foaming

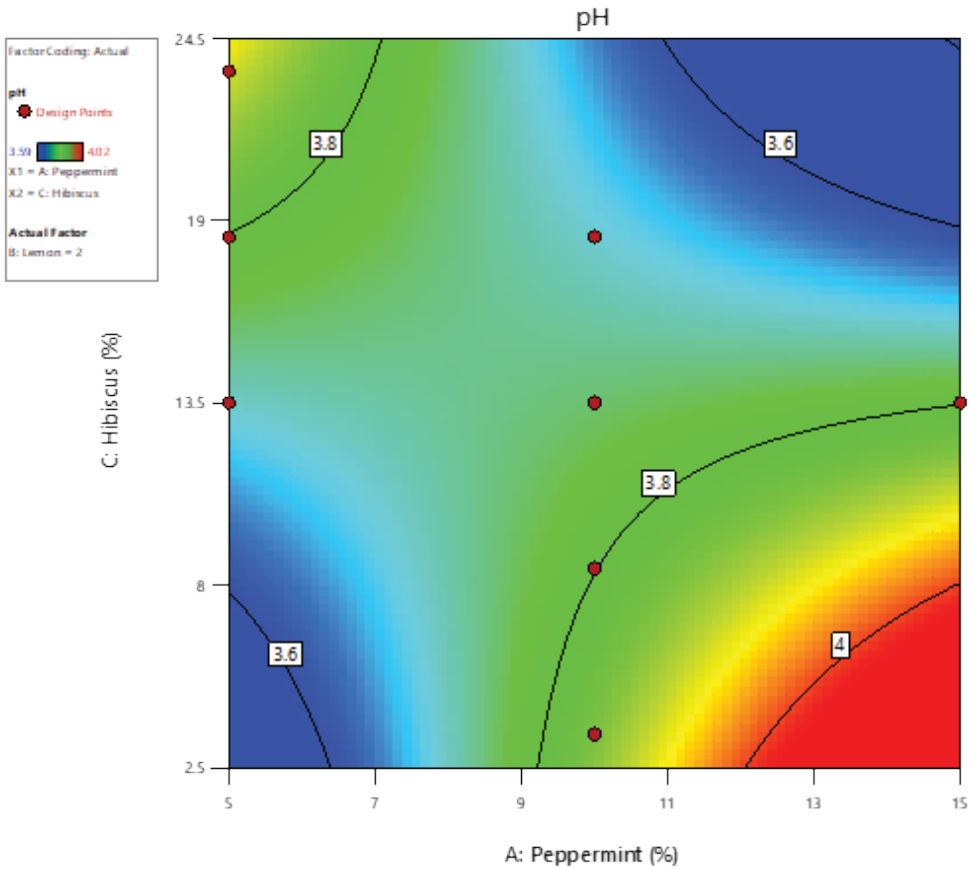

Figure 10: Effect of Peppermint (%) and Hibiscus (%) on pH

Physical Appearance/Visual Inspection

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 taste and odour sensitive persons was formed and random sampling was performed. All the formulation showed acceptable organoleptic characteristics as shown in Table 2.

As shown in the table 2, the formulation had the good characteristics with respect to physical properties. It has optimum acceptable odour, faint greenish colour and a smooth texture.

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 3 - 6.

Herbal shampoo formulations has an optimum particle size and good flow characteristics. For the shampoo Particle size is an important aspect; as it has a direct impact on the aesthetic values of the product which connects with person in use. While flow related characteristics; angle of repose and densitywas found to be adequate, which has to be considered while selecting packaging component is also acceptable.

Physicochemical evaluation:

Physicochemical evaluation of formulated herbal shampoos evaluated for dirt dispersion, detergency, cleaning, foaming and pH. The results presented in table 7.

Determination of pH

The pH of 10% shampoo solutions in distilled water was determined at room temperature 25°C. As seen from Table 7, all the formulations were of acidic pH and were ranged in between 3.18 to 4.92, which is near to the skin pH. Graphical representation presented in *Figure 1.*

The pH value has a significant effect on 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

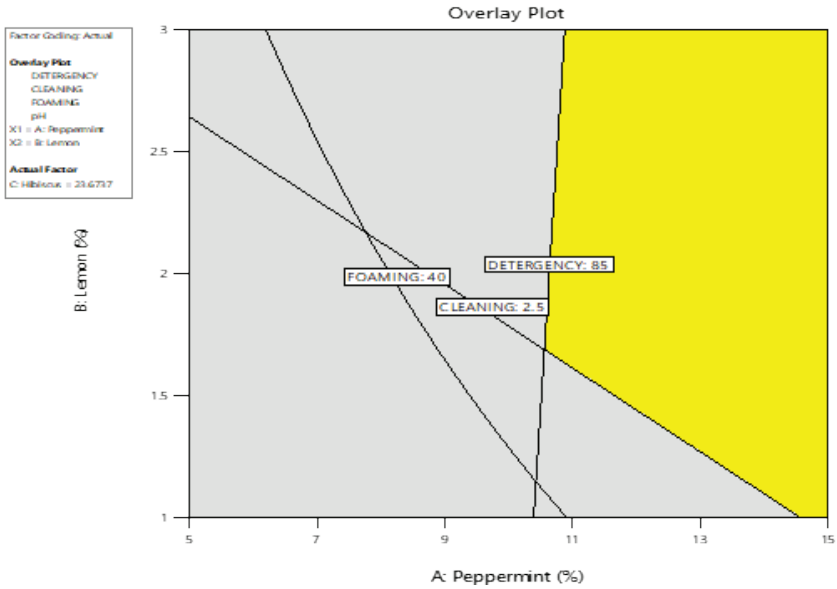

Figure 11 (a): Overlay plot – Effect of Herbal shampoo formulation variables on Peppermint (%) and Lemon (%)

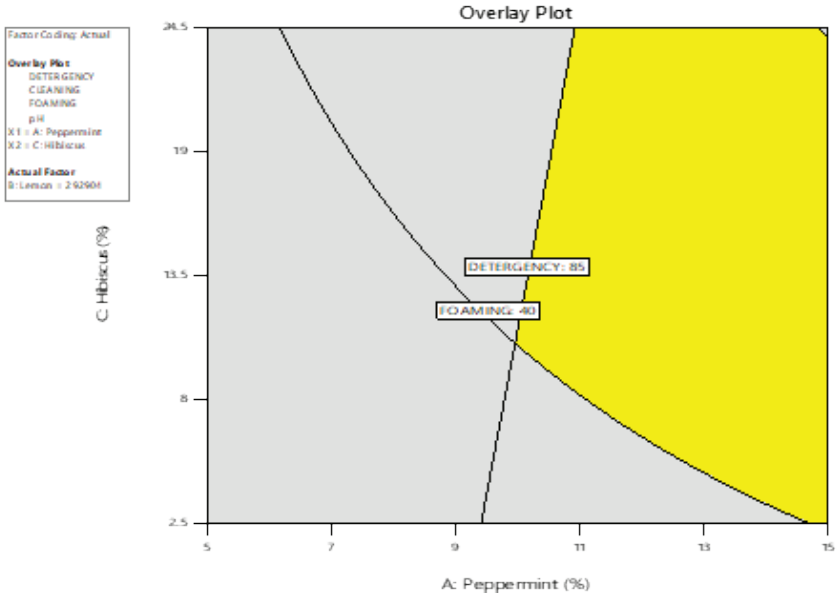

Figure 11 (b): Overlay plot – Effect of Herbal shampoo formulation variables on Peppermint (%) and Hibiscus (%)

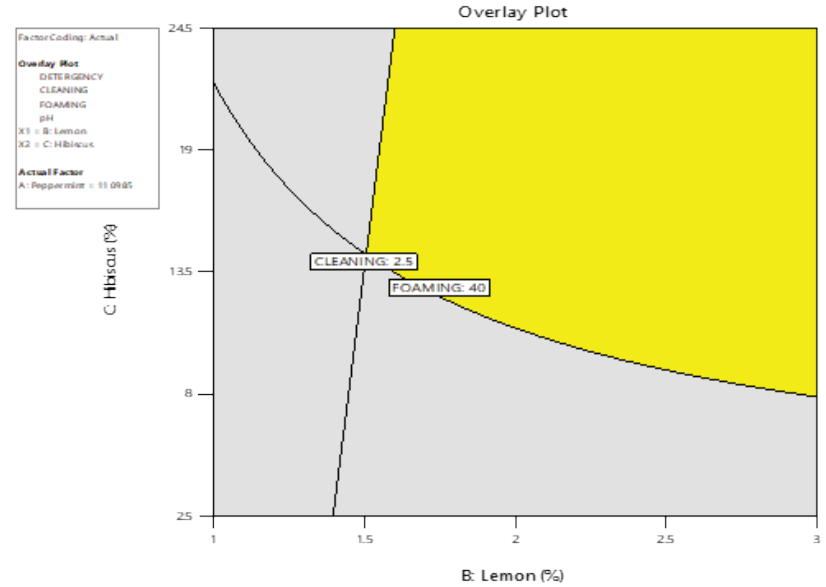

Figure 11 (c): Overlay plot – Effect of Herbal shampoo formulation variables on Lemon (%) and Hibiscus (%)

one of the ways to minimize damage to the hair (Baran and Maibah *et al.,* 1998). All the formulations are having an acidic pH more correctly mild acidic pH which will prevent swelling and promotes tightening of the scales, which finally results in an increase in glow of hairs. Thus formulations were found to be acceptable with regard to pH (Namita *et al.,*2013).

Dirt dispersion

Dirt dispersion is considered as a key criterion for assessment of cleansing action of shampoos. It involves the capacity of shampoo to rinse away ink from the foam or dirt that resides in foam is complex to rinse away and gets re-deposited on the hair. Shampoos that cause the ink to rinse away from the foam are considered of good quality. So the capability of shampoo to rinse away the ink is directly related to cleansing action (Ali *et al.*, 2011). All the tested formulations of shampoo contactedwith the ink in the water portion, proving their reasonable cleaning ability. All the formulations showed the light dispersion of ink in the water portion which shows their actual effectiveness. Amongst the formulations, peppermint plays major role in the cleansing action.

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 72% - 98%. From the result, it was concluded that the role of peppermint is important in the detergency. Graphical representation presented in *Figure 2.*

Although cleaning or soil/sebum removal is the primary aim of a shampoo, detergency is also an important aspect. The formulations containing higher amount of peppermint shown higher detergency in comparison. The cooling effect of peppermint might also plays an important role which might attribute to its detergency effect. The shampoos showed higher or same detergency in comparison with marketed formulation.

Cleaning action

The shampoos containing higher concentration of lemon showed higher cleaning action than other formulations comparatively. The herbal shampoos containing higher amount of lemon showed almost similar cleaning action as that of marketed formulation. The results of cleaning studies showed that the herbal formulations has significant cleaning ability

and it was found in between 1.70 %-4.50 %.Graphical representation presented in *Figure 3*.

As revealed in the results, there is a remarkable variation in the amount of soil removed by the herbal formulations. The herbal formulations containing highest concentration of lemon showed higher cleaning action than other formulations. In comparison with marketed formulations the prepared formulations showed comparable cleaning action (Solihah MA *et al.,* 2012).

Foaming ability and foam stability

Foaming is an important aspect while considering the aesthetic value of shampoo. Cylinder shake method was used for determining foaming ability. Formulated shampoos produced the foam volume above up to 48 mL; while marketed shampoos generated a foam volume of 60-65 mL. All the ingredients especially lemon and peppermint plays an important and similar role than hibiscus (Sarath*et* al., 2013). The foams generated by formulated shampoos were small, compact, uniform, denser and stable, similar as that of marketed shampoos. Graphical representation presented in *Figure 4*.

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. The conditioning performance results were presented in figure 5, it was concluded that hibiscus play major role in conditioning the hairs and higher concentration gives maximum conditioning feel, than marketed formulations.

The score of the conditioning performance of the tresses washed with formulated shampoos were found to have more conditioning effect than the marketed shampoo formulations. The results noticeably proved that the formulated shampoosare having superior conditioning performance levels and thus, will have smooth afterwash hairs.

Statistical Evaluation:

The present study is evaluated using Design Expert statistical design for predicting the cleaning, detergency and foaming responses of herbal powdered shampoo formulations. Thederived polynomial equations and contour plots aid in predictingthe values of selected independent variables for preparation of optimum herbal shampoo formulations with desired properties.The experimental results for Detergency, Cleaning, Foaming and pH are presented in Table 7.

Significant factors for Detergency

The Analysis of Variance (ANOVA) results are presented in Table 8.

Significant factors for Cleaning

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

Significant factors for Foaming

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

Significant factors for pH

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

From the statistical evaluation data, higher concentration of Peppermint and Lemon have a significant impact on detergency and cleaning action.

Foaming play a vital role in acceptance of herbal shampoos. The ingredients Peppermint, Lemon, Hibiscus along with their interactions of Peppermint & Hibiscus and interactions of Lemon & Hibiscus have a significant impact on foaming ability.

Lemon, Hibiscus and interaction of Peppermint and Hibiscus have a significant impact on pH.

The statistical evaluationsare useful to establish acceptable ranges for formulation variables. *Figure 11* shows the overlay plot of all of the responses. The Yellow zone indicates the acceptance criteria of an ideal shampoo formulationwith the optimal % range of each of the ingredient.

CONCLUSION

Statistical evaluation found suitable for identification of optimized formulations considering the individual and combination interactions between the herbal extracts; on the performance of powdered shampoos. Powdered shampoo formulations containing 15% of Peppermint, 1% to 3% of Lemon and 12.5% to 14.5% of Hibiscus shown better performance compared with marketed formulations. The formulations PS19, PS20 & PS21 were identified as the superior formulations; based on theirphysicochemical properties and performance ability by statistical evaluation. The optimized herbal powdered shampoos have an excellent cleansing, detergency, conditioning, foaming effects and are suitable for regular hair and has acceptable pH and organoleptic stability characteristics, compared with marketed formulations.The physicochemical properties were found stable in optimized formulations after three months of stability, indicating the formulations were suitably stable.

REFERENCES

Anusha P, Harish G, Pragathi KB, Durraivel (2013). Formulation and evaluation of herbal anti-dandruff shampoo. *Indian Journal* of *Research* in Pharmacy and *Biotechnology*, 1: 835-839.

Ashok K, Rakesh RM (2010). Evaluation of prepared shampoo formulations and to compare formulated shampoo with marketed shampoos. *International Journal of Pharmaceutical Sciences Review and Research,* 3:120-126.

A. Pooja, N. Arun, K. Maninder (2011). Shampoos based on synthetic ingredients vis-à-vis shampoos based on herbal ingredients: a Review, *International Journal of*

Pharmaceutical Sciences Review and Research, 7 (1): 41-46.

A. Potluri, S.S.K. Asma, N. Rallapally, S. Durrivel, G.A. Harish (2013). Review on herbs used in Anti-dandruff shampoo and its evaluation parameters, *Indo American Journal of Pharmaceutical Research,* 3 (4): 3266-3278.

A.R. Manikar, C.I. Jolly (2001). Formulation of natural shampoos. *International Journal of Cosmetic Science*, 23 (1): 59-62.

C. Sarath, K.V. Vipin, R.A. Ann, K.V. Lindumol, S. Arun (2013). Development and evaluation of antidandruff shampoo based on natural sources, *Journal of Pharmacy and Phytothera peutics,* 1(4): 10-14.

H.S. Ali, R.B. Kadhim (2011). Formulation and evaluation of herbal shampoo from *Ziziphus spina* leaves extract, *International Journal of Research in Ayurveda and Pharmacy*, 2 (6): 1802-1806.

J. Tarun, J. Susan, V.J. Susan, S. Criton (2014). Evaluation of pH of bathing soaps and shampoos for skin and hair care, *Indian Journal of Dermatology,* 59 (5): 442-444.

Khaloud AB, Shah AK (2014). Formulation, evaluation and comparison of the herbal shampoos with the commercial shampoos. *Journal of Basic and Applied Sciences*, 3: 301-5.

Nasrin A, Eskandar M, Azadeh RD (2007). Formulation of an herbal shampoo using total saponins of *Acanthophyllum squarrosum*. *Iranian Journal of Pharmaceutical Research*,6:167-72.

Namita, Nimisha (2013). Formulation and evaluation of herbal shampoo having antimicrobial potential. *International Journal of Pharmacy and Pharmaceutical sciences*, 5:708-712.

Patel, I., and A. Talathi (2016). Use of traditional Indian herbs for the formulation of shampoo and their comparative analysis. *International Journal of Pharmacy and Pharmaceutical Sciences*, 8 (3): 28-32.

P. Boonme, N. Pakpayat, K. Yotmanee, S. Kunlawijitrungsee, D. Maneenuan (2011). Evaluation of shampoos containing silicone quaternary microemulsion, *Journal of Applied Pharmaceutical Science,* 1: 59-63.

P.R. Shinde, A.U. Tatiya, S.J. Surana (2013). Formulation development and evaluation of herbal antidandruff shampoo, *International Journal of Research in Cosmetic Science*, 3 (2): 25-33.

P.U. Firthouse (2009). Effects of Ocimum sanctum and Azadiractaindica on the formulation of antidandruff herbal shampoo powder, *Der Pharmacia Lettre,*1 (2): 68-76.

Rasool BK, Ali HS (2011). Formulation and evaluation of herbal shampoo from *Ziziphusspina* leave extract. *International journal of research in Ayurveda and pharmacy,*2:1802-1806.

R. Baran, H.I. Maibah (1998). Cosmetic dermatology in children, *Text book ofcosmetic dermatology* (2nd ed.), CRC Press, London, 507-508.

Shinde PR (2013). Formulation development and evaluation of herbal anti dandruff shampoo. *International Journal* of Research in *Cosmetic Science,* 3:25-33.

Solihah MA, Wan R, WI Nurhanan (2012). Phytochemical screening and total phenolic content of *Malaysian zea mays* hair extract. *International Food Research Journal*, 19:1533- 1538.