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Fabrication and Evaluation of Herbal Hair Mask

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Herbal, Hair mask, Frizzy hair, Hair therapy, Olive oil

Abstract
Hair therapy treats dandruff, frizzy hair, and hair loss while also making hair healthy, bouncy, and glossy. Hair Therapy often starts with a mask and ends with a rinse, massage, and steam. Moreover, salon visits are expensive and chemical-based spa treatments only produce short-term improvements while having the potential to permanently harm the health of the hair. Synthetic chemical-based hair masks that are widely available on the market clog the pores of the scalp and render hair hydrophobic, which over time results in dry and brittle hair. So, in order to address the aforementioned issues, we seek to create a low-cost, self-applying herbal hair mask. The regular usage of this mask as a thorough hair repair and care regimen, particularly for dry and frizzy hair, is theorized. Olive oil and stearic acid served as the base for the hair mask. The study showed that the concentration of oil and alkali in hair masks affects their solid and dirt-dispersion properties. In light of the findings, it can be concluded that an affordable self-applicable hair mask can be created for thorough hair repair and hair care therapy, particularly for dry and frizzy hair.

1. Introduction

Essential oils, minerals, and extracts from traditional ayurvedic plants are used in herbal shampoos as remedial measures. Herbs provide the vital nutrition that hair needs to grow healthy and strong from the roots. Natural ayurvedic components, natural oils, minerals, and medicinal herbs are used to make herbal hair masks for hair loss. By nourishing the shafts and roots of your hair, these substances enhance the hydration in the hair. This thus lowers the likelihood of hair loss, hair that is loose, dry, and damaged. Herbal hair masks are designed to promote hair growth aim to strengthen the hair follicles by delivering vital oils and nourishment directly to the hair's base and follicles. In effect, this encourages the growth of new, strong hair

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roots, and promotes hair growth. Natural and necessary antibacterial characteristics included in herbal hair masks shield the hair and scalp from the sun's damaging UV rays, avoiding skin infections. New hair becomes healthy with everyday usage of herbal shampoos, therefore, making hair glossy, shining, and bouncy hair. Herbal hair masks preserve the hair's natural color and, with frequent use, can even make it seem better. Also, they maintain healthy, lustrous, bouncy hair with a balanced, healthy scalp.[1]

Hair masks can keep hair nourished and hydrated. They work particularly well on frizzy, dry, or damaged hair. Even some hair masks have the potential to strengthen hair and enhance scalp health. These hair masks spend more time penetrating and bolstering hair than your typical cleanser or conditioner, providing astonishing benefits with just one usage. They may even be able to moisturize dry hair and keep colored hair from fading. Hair masks are frequently developed using oils, kinds of butter, extracts, and other strengthening substances that are made to penetrate into the hair and provide noticeable results after only one use.[2]

The goal of the study includes the formulation and development of an herbal hair mask made with herbal ingredients, as well as evaluation and formulation optimization. Natural products used in this hair mask are mentioned below with their benefits. Olive oil has a high antioxidant content and supports the health of the hair and scalp. In addition to protecting the hair from cell damage, it also conditions, nourishes and improves the quality of the hair. The massage also nourishes the hair follicles while enhancing blood flow to the scalp.[3] Black Pepper oil enhance Hair Follicle Strength, Eliminate Dust and Dirt, Treat Dandruff, and Activate Scalp.[4] Pomegranate oil naturally hydrates dry, dull strands and shields hair from damaging environmental stressors on all hair types. It promotes blood flow to the scalp, gets rid of filth and dandruff, shields the follicles from harm, and promotes the growth of thicker, healthier hair. [5]

2. Methodology

Materials

All the herbal ingredients i.e., Olive oil, Black Pepper and Pomegranate powder were procured from Amazon. Chemicals like stearic acid, Tween 80, Cetyl stearyl alcohol were procured from Loba Chemie, Vadodara. All other ingredients were of HPLC or analytical grade.

Methods

Preparation of Herbal Hair Mask

The method opted for formulating hair mask was simple emulsification method. The non-aqueous phase consisting of olive oil, stearic acid, cetyl stearyl alcohol, and span 80 was taken in beaker A. The aqueous phase was taken separately in beaker B and consisted of pomegranate powder, Tween 80, and purified water. The contents of both beakers A and B was heated up to 80° C and after which the contents of aqueous phase were added to non-aqueous phase. The mixture was blended until the desired consistency was obtained. Subsequently it was left at room temperature for assessment of phase separation.

Preliminary Optimization

Preliminary 20 batches of hair mask were prepared to fix the limit of the oil and stearic acid with parameter of dirt dispersion and % solid content.

Optimization of formulation using Response surface design

Based on the preliminary optimization, the critical factors were selected and further optimized by 3^2 Full factorial Design. Here, the quantity of oil (ml) (X1) and amount of stearic acid (mg) (X2) were selected as independent variables whose response was checked on dirt dispersion (Y1) and % solid content (%) (Y2). 3^2 randomized full factorial design was made by Design Expert 10.0.1.0 software which gave 13 experimental runs. To maintain consistency, each batch of the hair mask was prepared in triplicate while ensuring all other variables remained unchanged.

Characterization of Herbal Hair Mask

pH Value

It was determined with the help of a pH meter and Litmus paper, 1% hair mask solution in distilled water was prepared and pH was determined at room temperature 25°C. [6]

Solid Content (%)

A clean, dry evaporating dish was weighed, along with 4 grams of hair mask added to it. Once the liquid

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portion of the hair mask was evaporated, the right weight of the hair mask was determined and the evaporating dish with hair mask was placed on the recent plate. After drying, the weight of the hair mask (solids content) was precisely determined. [2]

Dispersion of Dirt

A test tube was filled halfway with purified water and two drops of hair mask. One drop of India ink was added to the test tube and was covered with a stopper, and was shaken ten times. The amount of ink in the foam was categorized as none, Light, Moderate, and Heavy. [7]

Foaming Ability and Foam Stability

The foaming ability of the hair mask was assessed using the cylinder shaking method. A 1% hair mask solution, consisting of 50 mL, was placed in a 250 mL graduated cylinder and shaken 10 times while being supported by a hand. After one minute of shaking, the total volume of the foam generated was determined. The estimation of foam volume was done by shaking and measuring the foam volume at one-minute intervals for a total duration of five minutes.[8]

Skin Irritancy

The Skin irritation test was evaluated using the patch test method. A small amount the optimized formulation was applied to the hair and scalp and left for 48 hours 10. The scalp was checked for any signs of irritation and inflammation. [9]

Spreadability

To examine the spreadability of the hair mask, a wooden block and glass slide device were employed. A precisely measured 5 g of the hair mask was positioned on the underside of the block, followed by the placement of the movable upper slide onto the hair mask. The time taken for the upper slide to separate 5 cm from the assembly was then recorded. The formula was used to determine the spreadability.

$$S = \frac{m\ x\ l}{t}$$

S is the spreadability, m is the weight attached to the upper slide, l is the distance travelled by the upper slide, and t is the time it takes to separate the slides.[10]

Stability Studies

The thermal stability of optimized formulations was studied by placing in glass container and they were placed in a humidity chamber at 40±2°C temperature and 75±5% relative humidity and their appearance and physical stability were inspected for a period of 3 months at interval of 1 month.[11]

Statistical Analysis

The data values represented as mean ± SEM and the statistical difference calculated using F-test. The values giving $P < 0.05$, were considered significant.

Results

Preliminary Optimization

20 Preliminary batches were formulated to check the influence of the various parameters on the formulation of the hair mask.

The table for the preliminary batches is shown in the table 1

Batch No	Ingredients								Description
	Olive Oil(gm)	Black Pepper oil(gm)	Pomegranate powder (gm)	Stearic acid (gm)	Cetyl stearyl alcohol (gm)	Span 80 (ml)	Tween 80(ml)	Water (ml)	
HM1	5	1.5	5	2.5	3.5	1.5	1.5	upto 50 ml	Blending is not proper
HM2	5	2	4.5	2	3	1	1	upto	Temperature should be

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								50 ml	maintained
HM3	4.5	2.5	4.5	2.5	2.5	1	1	upto 50 ml	Consistency is not proper
HM4	4	2.5	4	2.5	2.5	1	1	upto 50 ml	Viscosity will be adjusted
HM5	3	2	3	2	2.5	1.2	1.2	upto 50 ml	Blending should be proper
HM6	3.5	2.5	3.5	2	2	1.5	1.5	upto 50 ml	Temperature will be maintained
HM7	3	2.5	3	1.5	2.5	1	2	upto 50 ml	Quantity of ingredients will be adjusted
HM8	3	2.5	2.5	2	2.5	1	1	upto 50 ml	Proper mixing is done
HM9	3	3	2	2	2.5	0.5	1.2	upto 50 ml	Stability is not proper
HM10	2	2	2	1.5	2.5	0.5	1.5	upto 50 ml	Consistency is proper but pH is high
HM11	5	2.5	2.5	2	2.5	0.5	2	upto 50 ml	Quantity of ingredients will be adjusted to low and high
HM12	4.5	2.5	4.5	2	2.5	0.6	1.5	upto 50 ml	Proper consistency is not maintained
HM13	4	2.5	4	2.5	2.5	0.6	1.5	upto 50 ml	pH will be adjusted
HM14	3.5	2.5	3.5	2.5	2.5	0.6	1.5	upto 50 ml	Viscosity should be high
HM15	3	2.5	3	2.5	2.5	0.5	1.2	upto 50 ml	Blending is slightly improper
HM16	2	2	2	2	2	0.5	1.5	upto 50 ml	Consistency is proper but stability should be checked
HM1	3	3	3	3	3	0.5	2	upto	Slight quantity

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7								50 ml	adjusts
HM18	2.5	2.5	2.5	2	2.5	0.6	1.5	upto 50 ml	Proper formulation obtained
HM19	2.5	2.5	2.5	2	2.5	0.6	1.5	upto 50 ml	To see any changes in formulation
HM20	2.5	2.5	2.5	2	2.5	0.6	1.5	upto 50 ml	Perfect formulation obtained

Optimization of Herbal Hair Mask by 3^2 Full factorial Design3^2 randomized full factorial design was made by Design Expert 10.0.1.0. This design was applied to study the effect of independent variables on dependent variables with 13 experimental runs. The quantity of oil (ml) (X1) and amount of stearic acid (mg) (X2) were selected as independent variables whose response was checked on dirt dispersion (Y1) and % solid content (%) (Y2). The amount of oil was taken as 1.5 ml, 2.5 ml and 3.5 ml and amount of stearic acid was taken as 1 mg, 2mg and 3 mg. Table 2 shows the influence of amount of oil and stearic acid on their responses.

Table 2: Optimization of Hair Mask by Response surface method design

Batch Code	Amount of Oil (X1)	Amount of Stearic Acid (X2)	Dirt Dispersion (Y1)	% Solid Content (Y2)
HM1	-1	-1	1	20.15
HM 2	-1	0	1	22.39
HM 3	-1	1	2	23.33
HM 4	0	-1	1	22.22
HM 5	0	0	1	24.19
HM 6	0	1	3	26.71
HM 7	1	-1	2	23.13
HM 8	1	0	3	24.66
HM 9	1	1	4	29.49
HM 10	0	0	2	25.57
HM 11	0	0	2	26.36
HM 12	0	0	1	21.29
HM 13	0	0	1	24.86

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The selection of significant term for dirt dispersion and % solid content after the Response surface method reduce quadratic model design significant term, Contour and 3-D surface plot for hair mask formulation and overlay of optimized formulation is shown in Figure 1, 2, 3, and 4 respectively. Response Surface method reduced quadratic model design ANOVA for dirt dispersion and % solid content and check point analysis for experimental design is shown in table 3, 4, and 5 respectively.

Figure1: Normal plot of Residuals for Dirt dispersion of after Response surface method reduce quadratic model design selection of significant term

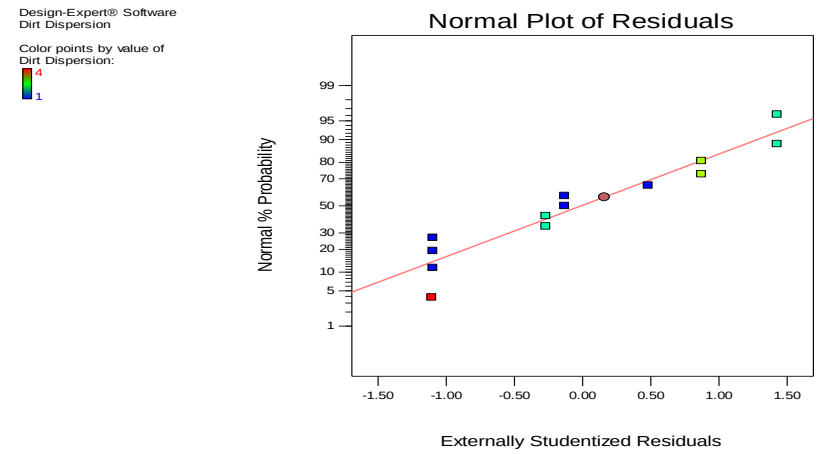

Table 3: Response Surface method reduced quadratic model design ANOVA table for Dirt dispersion

ANOVA for Response Surface Quadratic model						
Analysis of variance table [Partial sum of squares - Type III]						
Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	10.24	5	2.05	9.88	0.0045	significant
A-Quantity of Oil	4.17	1	4.17	20.10	0.0029	
B-Quantity of Stearic Acid	4.17	1	4.17	20.10	0.0029	
AB	0.25	1	0.25	1.21	0.3085	
A2	0.51	1	0.51	2.48	0.1596	
B2	0.51	1	0.51	2.48	0.1596	
Residual	1.45	7	0.21			

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Lack of Fit	0.25	3	0.084	0.28	0.8387	not significant
Pure Error	1.20	4	0.30			
Cor Total	11.69	12				

Figure 2: Normal plot of Residuals for % Solid content of after Response surface method reduce quadratic model design selection of significant term

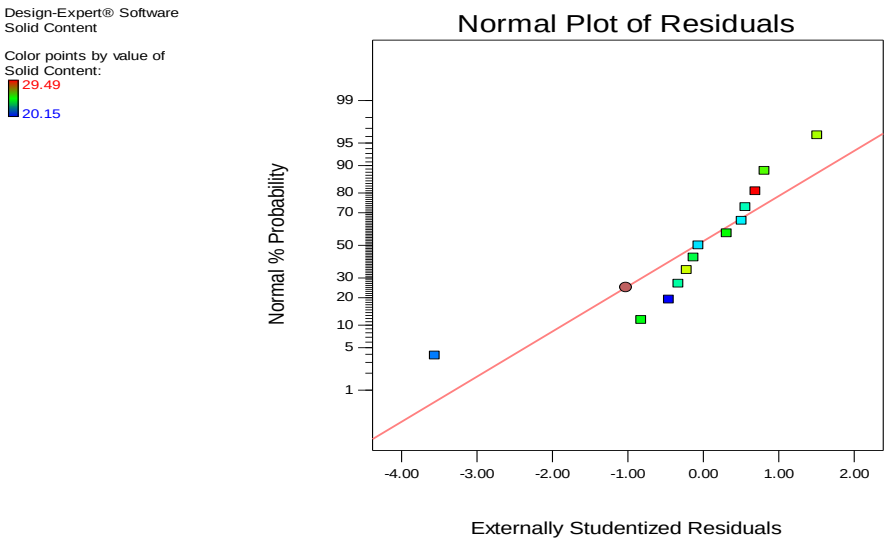

Table 4: Response Surface method reduced quadratic model design ANOVA table for % Solid content

ANOVA for Response Surface Quadratic model						
Analysis of variance table [Partial sum of squares - Type III]						
Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	58.36	5	11.67	4.78	0.0321	Significant
A-Quantity of Oil	21.70	1	21.70	8.89	0.0205	
B-Quantity of Stearic Acid	32.81	1	32.81	13.45	0.0080	
AB	2.53	1	2.53	1.04	0.3426	

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A2	1.33	1	1.33	0.54	0.4849	
B2	0.17	1	0.17	0.069	0.8002	
Residual	17.08	7	2.44			
Lack of Fit	1.95	3	0.65	0.17	0.9099	not significant
Pure Error	15.12	4	3.78			
Cor Total	75.44	12				

Figure 3: Contour and 3-D surface plot for hair mask formulation

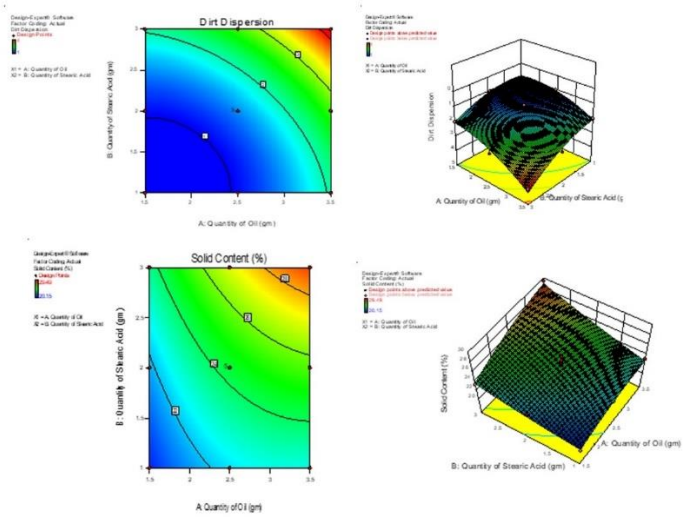

Figure 4: Overlay plot of optimized formulation

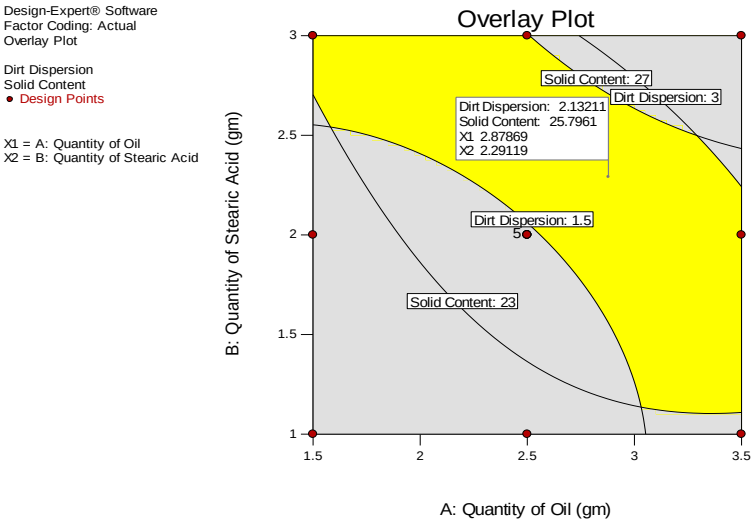

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Table 5: Checkpoint analysis of experimental design of Hair Mask

Sr.No	Amount of Oil	Amount of Stearic Acid	Dirt Dispersion		% Error	% Solid Content		% Error
			Predicted	Actual		Predicted	Actual	
1	3.47	2.27	1.8	1.85	2.70	24.66	25.12	1.83
2	3.49	2.25	3.51	3.59	2.22	22.15	22.28	0.58
3	3.49	2.27	2.64	2.75	4	26.78	27.14	1.32
4	3.47	2.28	3.39	3.45	1.73	21.13	21.99	3.91
5	3.48	2.26	2.84	2.89	1.73	22.25	23.11	3.721

Characterization of Herbal Hair Mask

pH

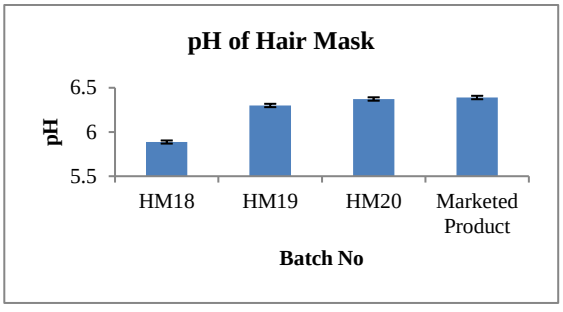
The optimized hair mask pH of Batch No HM18, HM19, HM20 and Marketed Product is shown in Figure 5 and Table 6.

Table 6: pH of Hair Mask

Sr.No	Batch No	pH
1	HM18	5.88±0.3
2	HM19	6.3±0.4
3	HM20	6.37±0.1
4	Marketed Product	6.39±0.2

(n=3)

Figure 5: pH of Hair Mask



Dirt Dispersion

The optimized batch HM 19 and marketed product demonstrated light ink dispersion in foam, indicating that no filth will remain in the foam; as a result, the created formulation is satisfactory which is shown Figure 6.

Figure 6: Dirt Dispersion of Hair Mask

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Solid content

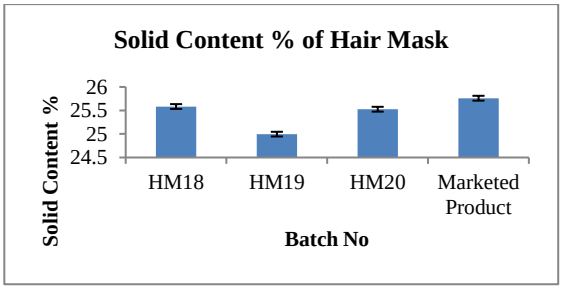
Hair mask with high solid content will be very difficult to rinse and hard to work with the hair. The solid content of prepared hair mask HM18, HM19, HM20 and marketed product is shown in Table 7 and Figure 7.

Table 7: Solid Content of Hair Mask

Sr.No	Batch No	Solid Content%
1	HM18	25.58±0.5
2	HM19	24.99±0.3
3	HM20	25.52±0.1
4	Marketed Product	25.76±0.7

(n=3)

Figure 7: Solid content of Hair Mask



Foamability

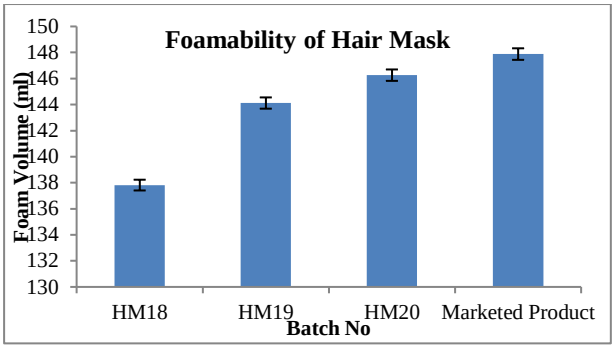
Foamability of Hair Mask HM18, HM19 and HM20 is shown in Figure 8 and Table 8.

Table 8: Foam volume of developed hair mask formulation

Sr.No	Batch No	Foam volume (ml)
1	HM18	137.8±0.5
2	HM19	144.1±0.3
3	HM20	146.2±0.8
4	Marketed Product	147.8±0.2

(n=3)

Figure 8: Foamability of Hair Mask



Skin Irritancy

A small amount of HM 19 and marketed product hair mask is applied to the hair and scalp and left for 48 hours. The scalp was checked for any signs of irritation and inflammation. No irritancy was observed.

Spreadability

Spreadability of HM18, HM19 and HM20 are shown in Figure 9 and Table 9.

Table 9: Spreadability of Hair Mask

Sr. No	Batch No	Spreadability
1	HM18	20.76±0.6
2	HM19	21.32±0.5
3	HM20	20.76±0.9
4	Marketed Product	20.61±0.3

(n=3)

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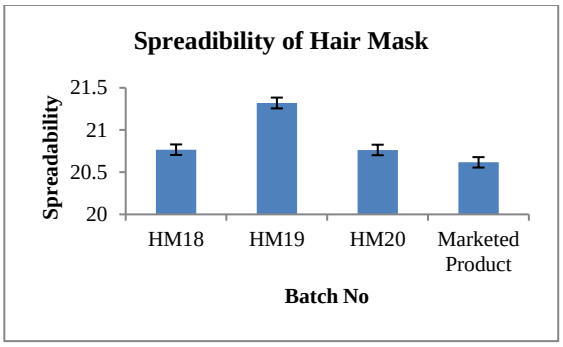
Figure 9: Spreadability of Hair Mask



Stability Studies of Hair Mask

The thermal stability of optimized formulation HM 19 was studied by placing in glass containers and it was placed in a humidity chamber at 40±2°C temperature and 75±5% relative humidity and its appearance and physical stability were inspected for a period of 3 months at interval of 1 month. Results of stability study of HM 19 is shown in figure 10 and table 10.

Table 10: Stability Studies of Hair Mask

Sr.No	Parameters	1 Month	2 Month	3 Month
1	Colour	White to Light pinkish	White to Light pinkish	White to Light pinkish
2	Odour	Slight pleasant	Slight pleasant	Slight pleasant
3	Texture	Fine smooth	Fine smooth	Fine smooth
4	pH	5.21±0.3	5.23±0.6	5.31±0.1
5	Solids contents (%)	20.11±0.5	20.18±0.3	20.17±0.1
6	Foaming (ml)	145±3.2	142±1.3	138±2.4

3. Discussion

Characterization of Herbal Hair Mask

Statistical soundness of the polynomial equation was established on the basis of analysis of variation (ANOVA) statistics. 2 D counter plot and 3 D response surface plots were constructed at fixed levels at a time. using the Design expert software (Version 10.0.1.0).

Final Equation in Terms of Coded Factors:

Dirt dispersion = 1.44828 + 0.833333A + 0.833333B + 0.25AB + 0.431034 A2 + 0.431034 B2--(1)

Final Equation in Terms of Coded Factors:

% Solid content = 24.3866 + 1.90167A + 2.33833B + 0.795AB + 0.692931 A2 + 0.247069 B2-----(2)

To achieve the simultaneous optimization of saturation solubility, the desirability function was utilized, and the total desirability was calculated using Design Expert software. The desirability value ranges from 0 to 1 and reflects the proximity of a response to its ideal value. The total desirability is determined by taking the geometric mean of the individual desirability values for each response (B). When the desired characteristics reach their ideal values, the individual desirability is assigned a value of 1 for the independent variables. Consequently, the total desirability also becomes 1.

The formulation optimization process involved setting

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desired targets for the responses. The target ranges for response B1 were set between 1 and 5, while for response B2, the target range was between 20% and 30%. Based on these targets, the software suggested various composition options for the formulation, starting with the highest desirability value. To validate the software's output, a checkpoint analysis was conducted, and the percentage bias was calculated. A low percentage bias value (<10%) for the checkpoint batch indicates reasonable agreement between the predicted and experimental values. Finally, the optimized composition of the hair mask was used for formulation development and evaluated for its physical characteristics.

pH Value

pH is a measure of acidity and basicity of a formulation. The range goes from 0 to 14, with 7 being neutral. pH of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions. pH of the hair mask should range from 5 to 7. pH was measured of HM18, HM19, HM20 and marketed product.

Solid Content (%)

The total solids content is expressed as a ratio of weights obtained before and after the drying process. The test protocol consists of placing a sludge sample in an oven or water bath at a temperature of 105 °C until a steady mass is obtained. Solid content was measured of HM18, HM19, HM20 and compared it with marketed product. Therefore, the prepared formulation can be easily work with the hair, that is, it can be easily applied on hair.

Dirt Dispersion

Dirt dispersion was measure of HM19 and marketed product. As the ink remained in the water and the optimized formulation was comparable to the marketed product, it was concluded that the formulation has good dirt dispersion ability.

Foamability

Foamability was measured of formulated batches no HM18, HM19, HM20 and comparable to the marketed product. Therefore, the optimized formulation of hair mask has good foamability.

Skin Irritancy

It is non-animal test designed to identify those chemicals and mixtures capable of inducing moderate skin irritation. Skin irritancy was measured of batch no HM19 and marketed product. No irritation to scalp was observed using optimized formulation of hair mask when compared with marketed one.

Stability Studies

Stability testing involves assessing the duration for which a formulation remains safe and effective under specific storage conditions. This is determined by subjecting the formulation to storage at defined conditions and conducting testing at specific intervals. The stability testing also includes evaluating the organoleptic properties such as odor and color of the formulations during the storage period. The results indicated that the formulations remained chemically and physically stable while maintaining their acceptable organoleptic properties.

4. Conclusion:

This study introduces a range of plant-based medicinal substances that have been proven effective in hair care preparations. The herbal hair mask presented in this research offers a simple solution for repairing hair frizz. Herbal cosmetics are highly favored for their non-toxic properties. This particular hair mask not only addresses frizz but also nourishes the scalp, promoting healthier hair. Regular use of this mask results in well-conditioned and frizz-free hair. In recent times, natural remedies have gained significant popularity worldwide due to their safety and minimal side effects when compared to chemical-based products. Herbal formulations can be easily prepared at home using readily available ingredients. Furthermore, the stability study conducted provides assurance regarding the shelf life of the herbal hair mask. Different parameters like organoleptic evaluation, pH, solid content, dirt dispersion, texture, and stability studies are used for evaluating and which shows the significant results. Thus, it can be concluded that based on the result that a cost effective self-applicable hair mask can be formulated for comprehensive hair repair and hair care treatment especially for dry and frizzy hair.

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