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Research Article

DESIGN, DEVELOPMENT AND CHARACTERIZATION OF NOVEL HERBAL HAIR STYLING PREPARATION

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ABSTRACT

Natural remedies are more acceptable in the belief that they are safer with fewer side effects than the synthetic ones. Herbal formulations have growing demand in the world market. The present work deals with the development and characterization of herbal hair styling preparation. Although various herbal formulations are available in the market, we propose to make use of green tea extract which have good solar protection activity and antioxidant activity. Various formulation batches i.e., F1 to F7 were prepared using gelling agent like Aqupec HV 500 HC, in varied concentrations. Prepared formulations (F1 to F7) were evaluated for various parameters like psychorheological characteristics, pH, viscosity, spreadability, active drug content, homogeneity, stickiness, skin irritation test, photographic evaluation along with sun protecting factor and antioxidant study. Amongst all the formulation studied formulation F4 was found optimum for all the parameter. This Gel found to be very effective to protect hair from photodamaging and photoageing.

Keywords: Herbal Formulation, pH, Viscosity.

INTRODUCTION

The hair follicle can be divided into three anatomical compartments: the infundibulum, isthmus, and the inferior segment. The upper follicle is permanent, whereas the lower follicle, the inferior segment, regenerates with each hair follicle cycle. The infundibulum extends from the skin surface to the sebaceous duct. The isthmus, the permanent middle portion, extends from the duct of sebaceous gland to the exertion of arrectorpilli muscle. The inferior segment consists of the suprabulbar area and the hair bulb. The major compartments of the hair follicle from the innermost to the outermost include the hair shaft, the inner root sheath, the outer root sheath, and the connective tissue sheath (Fig. 1.1).

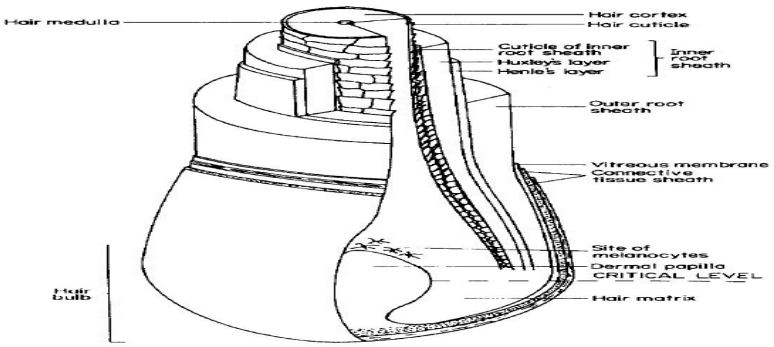

Fig. 1: Hair Follicle

HAIR GROWTH CYCLE

The hair produced by a follicle often needs to change and follicles possess a unique mechanism for this, the hair growth cycle.(Fig. 1.2). This involves destruction of the original lower follicle, and its regeneration to form another, which can produce hair with different characteristics. Thus, post-natal follicles retain the ability to recapitulate the later stages of follicular embryogenesis throughout life. Exactly how differently sized a hair can be to its immediate predecessor is currently unclear because many changes take several years (e.g. growing a full beard). Hairs are produced in anagen, the growth phase. Once a hair reaches full length, a short apoptosis driven involution phase, catagen, occurs, where cell division and pigmentation stops, the hair becomes fully keratinised with a swollen "club" end and moves up in the skin with the regressed dermal papilla. After a period of rest, telogen, the dermal papilla cells and associated keratinocyte stem cells reactivate and a new lower follicle develops downwards inside the dermal sheath which surrounded the previous follicle. The new hair then grows up into the original upper follicle (Fig. 1.2). The existing hair is generally lost; although previously thought to be due to the new hair's upward movement, a further active shedding stage, exogen, is now proposed.

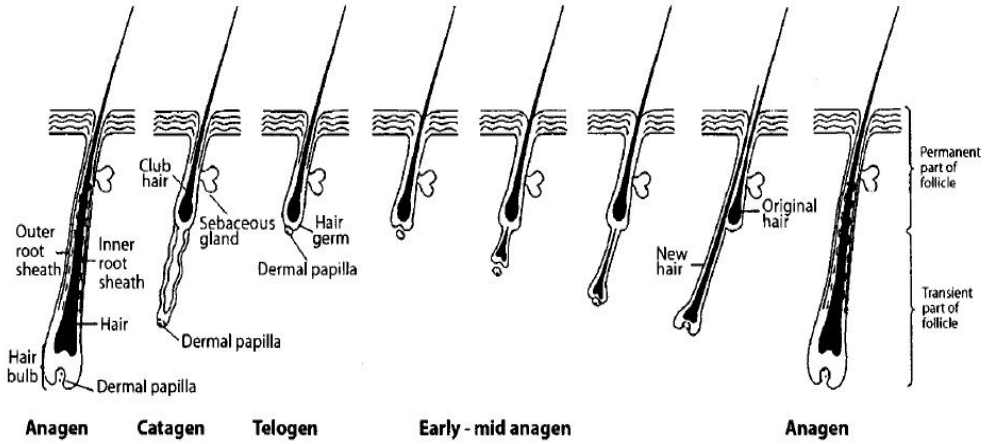

Fig. 2: The hair follicle growth cycle

Photoprotection and styling of hair

Photoprotection of hair is not a common topic addressed by the dermatologist, but it is an important part of maintaining the cosmetic value of the hair shaft. Solar exposure and oxidative coloring are the most common and important factors that can lead to color fading and loss in hair manageability, caused by alteration of the hair surface. The hair encounters more damage as it becomes more hydrophilic, the cuticles of the hair surface are lifted and the hair shows more split ends. In fact, ultraviolet (UV) radiation is cosidered to be the most damaging of all environmental factors. Hair has natural protection against the sun's rays. UV rays cause major changes in the mechanical ultra-structural and sensorial properties of hair, such as change of texture, a dry appearance, increase in porosity, loss of suppleness, etc. UV rays also effect the color and brilliance of hair. The UV induced damage involves deep changes in the structure of keratin caused by the photo-oxidation of amino acids, sterols and fatty acids, resulting in rupture of sulfur bridges, decomposition of lipids, decrease in melanin as well as numerous micro-molecular lesions.In conclusion, oxidative damage is the main reason for hair condition changes and the most important contributor to oxidation is UV radiation. Oxidative reactions in biological systems lead to the generation of free radicals. An efficient approach to alleviate the damage is the use of UV filters and antioxidants able to reduce the amount of free radicals. The present study is aimed to quantify the protection factor of UV filters and antioxidant containing hair care products.

The styling market is both format and fashion driven with an almost bewildering array of products available even in the simplest of supermarket displays. Formats vary from the traditional hair sprays through mousses, creams and pastes, putties, waxes and gels to the more recent powder stylers which are simply shaken on to the hair. The hair industry has provided us with numerous products to use before or after a physical hair styling procedure like curling with rollers, ironing, back-combing, and the like. These products help in changing the texture of the hair or in holding the hair in a particular style for long wear.

MATERIALS AND METHODS

Green tea extract was purchased from Natural Remedies, Bangalore.
Aqupec HV 500 HC was purchased from,Yasham Speciality Ingredients Pvt Ltd, Mumbai

Preparation of Hair Styling Gel

Various formulation batches were prepared according to the Table. The desired concentration of gelling agents were weighed accurately and dispersed in hot purified water (not more than 60°C; 50 % weight of the batch size) with moderate stirring, avoiding air entrapment and allowed to soak overnight. Desired quantity of methyl paraben was dissolved in remaining amount of water (50% of batch size) by gentle heating. Desired quantity of PVP was added to the and active ingredient was added to the above mixture this was finally mixed with previously soaked gel formulation. Perfume was added in sufficient quantity in all the formulations. Prepared formulations were filled in a suitable container and labeled accordingly. These preparations were further evaluated.

Table 1: Preparation of Hair Styling Gel

Ingredients					
Formulation code	Green tea extract (g)	Aqupec HV 505 C (g)	Glycerine (ml)	PVP (g)	Methyl paraben (g)
F1	0.025	0.1	6	1	0.15
F2	0.5	0.5	6	2	0.15
F3	1	1	6	3	0.15
F4	1.5	1.5	6	4	0.15
F5	2	2	6	5	0.15
F6	2.5	2.5	6	6	0.15
F7	3	3	6	7	0.15

Evaluation tests of hair styling preparation

To evaluate hair styling preparations following tests were carried out

In vitro evaluation

a) Psychorheological Characteristics

Psychorehological Characteristics were studied for colour, clogging, sudden viscosity change and feel properties.

b) Determination of pH

The pH of formulations were determined using digital pH meter. One gram of gel was dissolved in 100 ml of demineralised water and stored for two hours. The measurement of pH of each formulation were done in triplicate. Instrument was calibrated before use with standard buffer solutions at pH 4, 7, and 9.

c) Determination of Viscosity

100gm of each of formulation was weighed and transferred to beaker.The viscosity of formulations were determined with the help of Brook field viscometer(LV viscometer), spindle no 3 at 10 rpm for 5 min.Before measurement deaeration of gel was done and the gel was filled in appropriate wide mouth container. Samples of the gels were allowed to settle over 30 min at the assay temperature (25 ±/1^{0}C) before the measurements.

d) Stickiness/ Tackiness

2ml of the product was applied to glass plate at room temp and allowed to stand for 18 hours at constant temp and defined ambient humidity. The stickiness was determined Table 8.4 for all formulations subjectively by pressing the thumb against the film & removing it again scoring according to the following scale.
0 = no stickiness
1 = low stickiness
2 = medium stickiness
3 = high stickiness.

e) Homogeneity

The developed gel were tested for homogeneity by visual inspection, after the gel have been set in the container, spread on the glass slide for the appearance, tested for the presence of any lumps, flocculates or aggregates.

f) Spreadability Determination of Formulations

Spreadability of formulations were determined table 8.6 by an apparatus suggested by multimer et al. which was fabricated in laboratory & used for study. The apparatus consists of a wooden block, with a fixed glass slide with one end tied to weight pan rolled on the pulley, which was in horizontal level with fixed slide.An excess of hairstyling gel sample 1.5 gm was placed between two glass slide and a 1000 gm weight was placed on slided for 5 minutes to compress the sample to uniform thickness weigh (60gm) was added to the pan. The time (seconds) required to separate the two slides was taken as a measure of spreadability. It was calculated using the formula

$$S = m.l/t$$

Where, s = spreadability in gm.cm/sec
m= weight tied to upper slide
l= length of glass slide
t= time in seconds.

g) Active Drug Content

The amount of drug content was determined by taking 10 gm of Gel containing green tea extract which is equivalent to 10 mg was added in 50 ml volumetric flask containing ethanol and mixed it well with shaking or inverting the volumetric flask for two to three times.0.1 ml of this solution was diluted with 25 ml fresh ethanol and active content was determined using UV spectrophotometer at 270 nm active content of all formulations.

h) Stability study

The Hair Styling Gel were also subjected to the following condition of temperature and relative humidity during stability studies for 3 weeks
(1) 10°C ± 2°C at 75 ± 5% RH
(2) 25°C ± 2°C at 75 ± 5% RH
(3) 40°C ± 2°C at 75 ± 5% RH
Formulations were evaluated for various parameters were Psychorheological Characteristics, Viscosity, pH.

i) Determination of Sun Protecting Factor

1g quantity of Hair Styling gel was weighed individually, transferred to 100mL volumetric flask and finally diluted to volume with ethanol. Further, it was kept for ultrasonication for 5min and filtered through cotton filter, discarded the initially 10 ml. Afterwards 5.0 ml aliquot was transferred to 25mL volumetric flask and the volume was adjusted with ethanol. The absorbance of samples in solution form was measured in wavelength range of 290 to 320nm, every 5nm wavelength interval, and same was performed in triplicate for each sample and finally Mansur equation was applied to calculate the SPF. By UV spectrophotometric technique and employing a simple formula developed by Mansur et al., 1986, in vitro SPF can be calculated by following equation-

$$SPF = CF \times \sum_{290}^{320} EE(\lambda) \times I(\lambda) \times Abs(\lambda)$$

Where EE (I) - erythemal effect spectrum; I(I)-solar intensity spectrum
Abs-Absorbance of sunscreen product; CF-correction factor

Table 2: Values of EE x I

Wavelength (λ nm)	EE X I (normalized)
290	0.0150
295	0.0817
300	0.02874
305	0.3278
310	0.1864
315	0.0839
320	0.0180
Total	1

j) Free Radical Scavenging Activity - Superoxide Scavenging Activity

The reaction mixture contained 2.650 ml phosphate buffer, 0.1ml NBT, 0.2ml KCN, 0.5ml riboflavin and different concentrations of ethanolic extracts of the sample in a final volume of 3ml. The tubes were illuminated with an incandescent lamp for 15 minutes. Optical density was measured at 532 nm before and after illumination. The percentage of inhibition of super oxide generation was evaluated by comparing the absorbance value of control and test.

Percentage inhibition = C-T ×100

C=absorbance of control,
T=absorbance of test.

In vivo evaluation

a) Skin irritation test

The skin irritation was carried out on human volunteers. For formulated gel, volunteer were selected and 1.0g of formulated gel was applied on an area of two square inch to the back of the hand. The volunteers were observed for lesions or irritation.

b) Photographic evaluation

This was carried out on human volunteer. Hair styling Gel was applied on hair. Then photographs were taken before and after application of the product.The difference can be distinctly visualized.

RESULTS AND DISCUSSION

Formulations were evaluated by different tests. Based on the results best formulation was selected as final formulation.

Table 3: Psychorhelological characterstics of Hair Styling Gel

Parameter	Colour	Clogging	Sudden viscosity change	Feel
Formulation code				
F1	Pale yellow	NC	NC	Smooth
F2	Pale yellow	NC	NC	Smooth
F3	Yellow	NC	NC	Smooth
F4	Yellow	NC	NC	Smooth
F5	Dark yellow	NC	NC	Smooth
F6	Dark yellow	NC	NC	Smooth
F7	Dark yellow	C	C	Tacki

F- formulation, NC- No Change, C – Change.

Psychorheological characteristics of formulation 7 was found to be tacky feel, and shows clogging, hence these formulation was rejected for further study.

Table 4: pH and viscosity determination of Hair Styling Gel

Parameters	pH	Viscosity (cp)
F1	6.28	12800
F2	6.34	31200
F3	6.65	32000
F4	6.78	34000
F5	6.85	35200
F6	6.82	36400

Viscosity of formulations were in proper range except formulation F1 which was found to have low viscosity, hence was rejected for further study.

Table 5: Various parameters determination of Hair Styling Gel

Parameters	Stickiness	Homogeneity	Spreadability (gm.cm/sec)	Active Drug Content (%)	Skin irritation test
F2	1	No Lumps	18.36±1.01	89.16±0.12	No Irritation
F3	0	No Lumps	21.66±0.70	92.93±0.50	No Irritation
F4	0	No Lumps	24.63±1.35	94.42±0.90	No Irritation
F5	2	No Lumps	26.21±1.15	97.03±0.1	No Irritation
F6	3	No Lumps	28.03±1.16	97.23±0.60	No Irritation

Various parameters such as stickiness, homogeneity, spreadability, active drug content were found in proper range in above formulations so were used for further study

Table 6: Stability study of Hair Styling Gel

	Psychorheological Characteristcis				Parameters	
Formulation code	**Colour**	**Clogging**	**Sudden viscosity change**	**Feel**	**pH**	**Viscosity (cp)**
After 1 week (10·C)						
F2	Pale yellow	NC	NC	Smooth	6.20	30000
F3	yellow	NC	NC	Smooth	6.42	31200
F4	yellow	NC	NC	Smooth	6.50	33200
F5	Dark yellow	NC	NC	smooth	6.65	34000
F6	Dark yellow	NC	NC	Smooth	6.86	36000
After 2 weeks (25·C)						
F2	Pale yellow	NC	NC	Smooth	6.01	29200
F3	Yellow	NC	NC	Smooth	6.38	30400
F4	Yellow	NC	NC	Smooth	6.45	32800
F5	Dark yellow	NC	NC	smooth	6.56	32400
F6	Dark yellow	C	C	Tacki	6.68	35200
After 3 weeks (45·C)						
F2	Pale yellow	NC	NC	Smooth	5.59	28800
F3	Yellow	NC	NC	Smooth	6.21	30000
F4	Yellow	NC	NC	Smooth	6.40	32000
F5	Dark yellow	C	C	Tacki	6.43	32400
F6	Dark yellow	C	C	Tacki	6.56	34000

During stability study changes were seen in all formulations. Psychorheological characteristics of formulation F5 and F6 were found to be changed during stability study for 3 weeks, hence F5 and F6 formulation were rejected for further study

Table 7: SPF Determination and Free Radical Scavenging Activity of Hair Styling Gel

Parameter	SPF	Antioxidant
Formulation code		
F2	12.9	-
F3	13.125	-
F4	14.96	57.5 %

As the concentration of active ingredient increases its sun protecting factor also increases. Formulation F4 was selected as it has highest SPF hence this formulation (F4) was used for further work and antioxidant test was performed for F4.The Hair Styling Gel was found to have effective antioxidant activity in a suitable range.

Photographic evaluation


In these photographic evaluation before and after application of Hair Styling Gel was shown. These photographs indicate after application hair were in proper style and were prevented from UV.

CONCLUSION

Hair Styling Gel F4 which was formulated showed a good psychorheological characteristics, pH, spreadability, stickiness, homogeneity, sun protecting factor, greater active content, free radical scavenging activity. Hence, this study showed that F4 was the best formulation for Hair Styling Gel. The Hair Stying gel concluded that it can be used to prevent dry-damaged hair, to alter the color or structure of the hair shaft, to prevent loss of proteins, visible changes can also be avoided. This Gel found to be very effective to protect hair from photodamaging and photoageing. The Hair Syling Gel can also be used with additional ingredients such as conditioning, antidandruff, colouring properties. This Hair Styling Gel will have good scope in future as day by day UV radiation causes are increasing.

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