STYLING POLYMERS AND ITS INFLUENCE ON MECHANICAL PROPERTY IN HAIR STYLING GEL

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ABSTRACT

A hair styling aid arranges and maintains the hair in a groomed position or desired position and imparts conditioning, shine, body, and increased manageability. Many hair styling products are available in market in the form of hair spray, gels, mousses, creams, waxes, lotions, pomode etc.; among these hair gels plays a vital role in hair styling segments. Evaluation of mechanical bending experiments is immense useful to estimate the stiffness of the hair due to the application of hair gel, similarly high humidity curl retention experiments helps to find out the style longevity.   Measurement of exact dosage incorporation is immense useful to minimize the cost of the formula and other hair damage issue.   Various concentration of styling polymers added in the formula and prepared the separate formula, to measure the stiffness and curl retention property. . Study results clearly indicates that the increase the concentration of styling polymers directly proportional to the stiffness value. Similarly the higher concentration of the polymers improves the curl retention property also. The curl retention property value ranged between 81.00 and 86.0 %. However the stiffness value gradually increases when the addition of excess styling polymers and stiffness value (N) varied between 6.75 and 12.42. Unique hair styling polymer and carbomer combination delivers the high humidity resistance, excellent curl retention, superior hold and no flakes and it meets today market trend and consumer need.   Measurement of stiffness value helpful to classified the hair gel into four different categories like, mild, strong, gentle and super hold category. Polymer dosage finalized based on the mechanical properties like curl retention and stiffness value, it immense helpful to minimize the final cost of the formula.

Keywords: Carbomer; mechanical property, stiffness, curl retention, styling polymers, hair gels

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Introduction

Human hair is a complex and nano composite protein fiber and it have the physical appearance and mechanical property depends upon the various crucial factors like ethnic origin, cleaning practice, grooming pattern, chemical treatment and impact of environmental conditions (Hearle, 2000; Zhenxing*et al.,* 2009). Recent findings in beauty care technology are helpful to maintain the health of hair and help to maintain the style pattern of the hair. In recent days hair style segment play a vital role in social and self perception aspects. Hair cosmetics can be distinguished into two main groups like temporary effect on hair and permanent effect on hair. Shampoo, conditioners, hair style gel, pomade, hair wax, temporary colours are fall under the temporary effect category, wave, relaxers, bleaches, permanent colour are fall under the permanent effect category (Jachowics and Mc Mullen, 2002; Raymond *et al.,* 2007). A hair styling aid arranges and maintains the hair in a groomed position or desired position and imparts conditioning, shine, body, and increased manageability. Many hair styling products are available in market in the form of hair spray, gels, mousses, creams, waxes, lotions, pomode etc.; among these hair gels plays a vital role in hair styling segments. Styling aids are in general safe for skin and hair; however, misuse can result in hair damage. Polymers play a crucial role in hair styling products (Raymond *et al.,* 2007; Haaf*et al.,* 2011); it provides the desired styling to the end users. Many cosmetic raw material

suppliers provide different type of polymers as a hair styling aid. These polymers are helpful to increase the hair volume, stiffness value, curl retention, film forming etc.; the general hair fixatives are listed as following category, like Polyquaternium and its derivative, guar cum and its derivative, poly vinyl pyrolidine and its derivative, acrylates type co-polymers, PVP-VA co polymers / cross polymers etc. Hair styling product performance rated based on the stiffness, curl retention and flake issue. Evaluation of mechanical bending experiments is immense useful to estimate the stiffness of the hair due to the application of hair gel, similarly high humidity curl retention experiments helps to find out the style longevity time. The above mentioned two mechanical tests is immense useful to quantify the performance of hair gels and immense useful to the formulator for adjusting the styling polymer and thickener to delivers the desired result to the end users. Measurement of these physical and mechanical properties will be immense helpful to finalize the dosage of the polymers and help to classification of hair styling aids; based on their holding properties (Maria *et al.,* 2009; Abraham &Nall, 2009) . In general hair styling gels are classified into mild, strong, gentle and hard/super hold category. Measurement of exact dosage incorporation is immense useful to minimize the cost of the formula, prevent from more deposition andother hair damage issue. Many scientists exclusively work with different polymers

dosage and curl retention pattern with different polymers, however there is no authentic documents in acrylates 3 cross polymers and its derivative (Suchita*et al.,* 2012; Mankhade*et al.,* 2010; Ankita&Biyani, 2014) . So we have aimed to generate the

documents about the influence of different dosage of acrylates cross polymers-3 on stiffness and curl retention; based on stiffness value classified the developed formula into different category.

Materials and methods:

Water based hair gel prepared and the detailed formulation details present in table 1.

Table 1.   Formulation details of in-house

S.No	Raw material details	Function
1	Water	Carrier
2	Carbomer	Thickener
3	DISODIUM EDTA	Chelating agent
4	Acrylytes cross polymer -3	Styling polymer / film forming
5	Alkalizer	For neutralizing the carbomer and styling polymer
6	DL PANTHENOL	Conditioning to the hair
7	EMULGIN HRE 40 (PEG-40 HYDRO. CASTOROIL)	Perfume solubiliser
8	Perfume	For odour
9	Plant or herbal actives	For hair beneficial claims

Various concentration of styling polymers added in the formula and prepared the separate formula, to measure the stiffness and curl retention property. Unique carbomer used in the formula, and it provides the breakthrough performance in hair styling applications without compromising the gel rheology and aesthetic feel of the final products. Various

ranges of Acrylates cross polymer -3 used in the formula and developed the various options for estimating the holding property. Unique/novel carbomer used as a thickener, it helps and promotes the transmittance of the hair gel. Alkalizer was selected from tritheanolaminie, amino methyl propanol or sodium hydroxide and the addition of alkali based on the pH and

viscosity of hair gel. The pH of the hair gel varied between 6.5 and 7.5.

Measurement of Stiffness test:

Stiffness test was performed by using the Texture Analyser Model TA.XT; the three bend fixtures are used for the stiffness test of the hair. Stiffness test was useful for the determination of the bending stiffness of the hair gel. Stiffness of hair gel measured in flat and clean hair tresses is used. Around 2.5 gm of hair tresses prepared with 2.0 cm width; 20 cm height and clean with the shampoo wash and dried; then 0.8 gm of product applied to each flat tress i.e. 0.32gm of product per gram of the hair; then allowed to dry overnight at 25 deg C and 50% Relative Humidity (RH) condition. Stiffness value was measured with help of Texture analyser, during the measurement the gel film breaks and the needed force in Newton was measured. Five hair tresses are used for the each formulation to find out the reproducibility and statistical analysis.   The results are summarized in Figure 1.

Flaking test:

The overuse of polymer-based hair fixatives can lead to flaking. To test flaking, usually panelists are involved. The fixative is applied to the hair tresses and allowed to dry. The hair tresses are hung up onto a supporting board and a small-toothed comb is then passed through the hair tresses. The hair, comb, and area under the support stand are inspected and graded by panelists to evaluate flaking.

High humidity spiral curl retention test:

High humidity spiral curl method measures the percent of curl retention of hair tresses at 90% relative humidity at 25 deg C. Hair tresses are wrapped in a corkscrew specially developed for the curl retention test. The spiral configuration is more realistic as well as more challenging since there is no overlap of the hair during the testing period. 0.1 gm of test samples applied to 0.5 gm hair tresses and the hair tresses placed / hung vertically. Hung hair tresses are placed in humidity chamber and temperature and humidity was monitor and recorded in every hour. Length of the hair tresses was measured before and after exposure through spiral corkscrew and the percentage of curl retention was measured by the below mentioned calculation,

Percentage of curl retention = $100 [(L-Lt)]/(L-L_0)$

L = length of hair tresses before treatment

Lo = Length of hair tresses before curling

Lt = Length of hair tresses after exposure as a certain experimental time.

Physico chemical parameters:

pH of hair gel measured by using the pH meter, the electrode was immersed in the gel and recorded. 100 gm of developed formula taken in glass beaker and viscosity tested by using Brookfield DV3T model Rheometer/viscometer at Spindle No. 6, RPM20 at 25 deg C for 5 minutes. The complete data presented in Table 2.

Results:

Physico-chemical parameters of various developed gel estimations are summarized in table 2. As mentioned earlier the various concentration of styling polymers added in the formula and namely F1, F2, F3 and F4, irrespective of the concentration of styling polymer does not affect the clarity of the hair gel. The samples pH value ranged between 7.00 and 7.50, higher concentration of styling polymer does not affect the rheology, aesthetic feel of the hair gel. Viscosity of developed hair gel ranged between 50000 and 60000 cps. The density of hair gel varied between 0.99 and 1.05 gm/mL. All the developed hair gel are clear and having the higher transmittance value and ranged between 92.5 and 93.0%. Stiffness value (N) measured for the developed four different concentration of acrylates cross polymer formula and the values are furnished in Fig. 1. Study results clearly indicates that the increase the concentration of styling polymers directly proportional to the stiffness value. Similarly the higher concentration of the polymers improves the curl retention property also. The curl retention property value ranged between 81.00 and 86.0 %. However the stiffness value gradually increases when the addition of excess styling polymers and stiffness value (N) varied between 6.75 and 12.42.

Table No. 2. Physico chemical properties of developed hair gel

S.No	Parameters	F1	F2	F3	F4
1	Clarity	Clear	Clear	Clear	Clear
2	Appearance	Clear Gel	Clear Gel	Clear Gel	Clear Gel
3	pH as such	7.01	7.10	7.06	7.05
4	Viscosity S6 @ RPM20 – 25°C	52000 cps	53000 cps	52500 cps	53500 cps
5	Density g/mL @25°C	0.992	0.995	0.996	0.998
6	Transmittance %	92.5	93.0	92.8	92.6

Table No. 2. Stiffness and curl retention pattern of developed hair gel

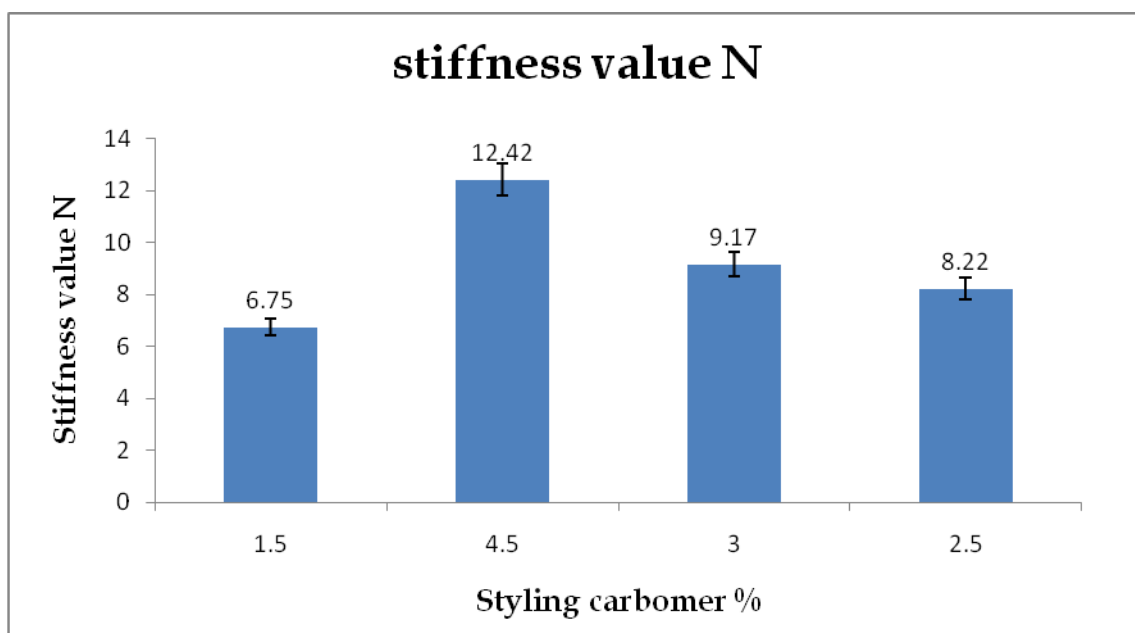| S.No	Parameters	F1	F2	F3	F4
1	Carbomer %	0.85	1.0	1.0	1.0
2	Styling polymer %	1.5	3.0	4.5	2.5
3	Stiffness value (N)	6.75 ±0.61	9.17 ± 0.65	12.42 ± 0.85	8.22 ± 0.52
4	Curl retention property (%)	82.0%	85%	86.0%	81.0%

Fig. 1 Stiffness value measured various concentrations of styling polymers

Discussion:

The hair fixative polymers helps to fix the polymer in the hair surface, different polymers behave different mechanism with the hair. Concentration of polymers plays a crucial role in the resistance property with high humidity condition and also vital role in the curl retention pattern (Apoorva Mahajan, 2016). Hair styling mechanism was explained by the following way, initially the fixative polymers deposited or coated on the hair surface. Applied polymers promote the capillary force between the hairs and it helps to attract the each hair strands. Applied or deposited polymers are dried and provide the strong and hold to the hair. Deposited polymers provide the stiffness to the hair until the hair was washed or deposited films are break up by the mechanical forces(Rigoletto*et al.,* 2007). Many researchers proved that the higher the concentration of polymers provide the higher holding and curl retention pattern (Wood and Hoessel, 2004; Wood *et al.,* 2004; Denise Wade Rafferty et al., 2008). Similar kind of observations is noticed in our study; the 1.5% of polymers delivers the 6.75 stiffness value (N), however the 4.5% of polymers containing formula delivers the 12.42 stiffness value (N). All the developed formula delivers the higher curl retention property and it ranged between 80 and 86%, the study results revealed that the fixative polymers provides the higher amount of curl retention property. Mechanical property of hair estimation is immense useful to identify the exact dosage of the polymer to be add to delivers the desired results. It will be immense useful to cost optimize the

formula as well as unique tool to develop the superior products.

Conclusion:

Unique hair styling polymer and carbomer combination delivers the high humidity resistance, excellent curl retention, superior hold and no flakes and it meets today market trend and consumer need. Measurement of stiffness value helpful to classified the hair gel into four different categories like, mild, strong, gentle and super hold category. Polymer dosage finalized based on the mechanical properties like curl retention and stiffness value, it helpful to minimize the final cost of the formula.

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