32nd IFSCC Congress
London 19-22 September 2022

Hydrolyzed Corn Starch: Sustainable Alternative to Synthetic Styling Polymers for Clear Hair Gels

Poster ID: 615

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Introduction:

Hair care consumers today are increasingly focused on selecting products that contain natural ingredients without sacrificing performance. Attempts to introduce natural-based hair fixatives have often struggled with matching either the performance or optical clarity of synthetic fixatives. In addition to product performance, consumers are becoming more focused on the concept of clean beauty. Clean beauty is focused on selecting sustainable ingredients that are safe for the environment and the consumer [1]. To address the needs and expectations of today's consumers, a novel hydrolyzed corn starch (HCS) has been developed for use in hair styling applications. This HCS material is biodegradable, 100% naturally derived, and cold water dispersible.

Materials & Methods:

1) Preparation of hair gels with Carbomer rheology modifier

Weigh 50g water and 3g glycerin into a beaker and stir. Add Carbomer and continue stirring until all powder is completely disolved. In a separate beaker, add Phase B ingredients and mix until fully dissolved. Add Phase B to Phase A and mix for 5 minutes. Add Phase C to Phase AB. Stir and adjust pH if necessary.

Table 1. Hair gel formula.

Phase	Tradename / INCI	Weight %
A	Water	50.0
A	Glycerin	3.0
A	Carbopol 980 / Carbomer	1.0
B	VERSENE™ Crystals Chelating Agent / Disodium EDTA	0.1
B	Fixative Polymer	1.0-5.0
B	Phenoxyethanol	1.0
C	Triethanolamine	1.0

2) Preparation of hair gels with natural rheology modifiers

Formula 1 – Add water to beaker and begin mixing. Add glycerin, hydrolyzed corn starch, disodium EDTA, and phenoxyethanol while continuing to mix. Add hydroxyethylcellulose, mix for 5 minutes, then add triethanolamine. Mix for 30 minutes. Add lactic acid and mix for 5 minutes.

Formula 2 – Add water and hydrolyzed corn starch to beaker and begin heating to 80°C while mixing. Once hydrolyzed corn starch is fully solubilized, add disodium EDTA while continuing to heat to 80°C. After reaching 80°C, add carrageenan rheology modifiers. After carrageenans are fully solubilized, remove from heat and allow formula to cool while continuing to mix. Once below 40°C, add phenoxyethanol.

Table 2. Hair gel formulas with natural rheology modifiers.

Tradename / INCI	Formula 1	Formula 2
Water	91.87	94.40
MaizeCare™ Clarity Polymer / Hydrolyzed Corn Starch	3.00	3.00
Glycerin	3.00	
VERSENE™ Crystals Chelating Agent / Disodium EDTA	0.10	0.05
Phenoxyethanol	0.90	0.50
CELLOSIZE™ Hydroxyethyl Cellulose PCG-10 / Hydroxyethylcellulose	0.80	
Genugel Carrageenan CG-130 / Carrageenan		0.30
Genuvisco Carrageenan CG-131 / Carrageenan		1.75
Triethanolamine	0.20	
Lactic Acid	0.13	

The hair gels from Tables 1 and 2 were analyzed using the following test methods.

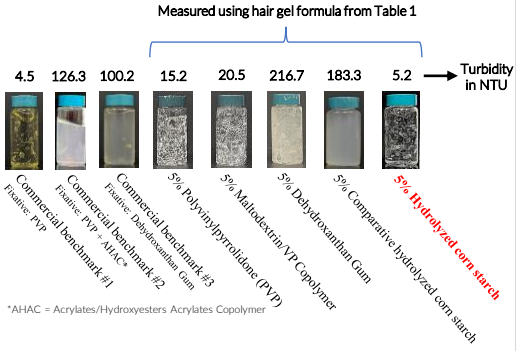
- Clarity was measured using a turbidimeter and results reported in Nephelometric Turbidity Units (NTU).
- Stiffness was measured using a MTT160 instrument from Dia-Stron Limited. Virgin Brown hair tresses were treated with hair gel and allowed to dry overnight prior to testing. The peak force (stiffness) was measured by pressing the curled tress to 25% of its initial diameter.
- Curl retention was measured by treating 3g hair tresses with 0.3g of hair gel. The hair tresses were curled and allowed to dry overnight. After drying the tresses were placed in a humidity chamber at 25°C and 80% relative humidity for 24 hours.

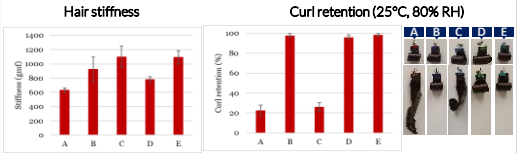
3) Vapor absorption study

A vapor absorption study was run on neat hydrolyzed corn starch and polyvinylpyrrolidone. Samples of each raw material were dried at 100°C for 5 minutes. Samples were then placed in a humidity chamber for 4 hours. The percent increase in weight after exposure to a controlled humidity environment was measured at 10%, 30%, 50%, and 70% relative Humidity, respectively.

Results & Discussion:

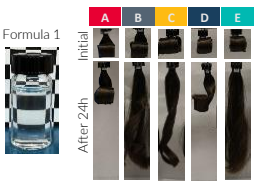
The hair gel formula from Table 1 was used to benchmark the performance of hydrolyzed corn starch (HCS) against other hair fixatives.



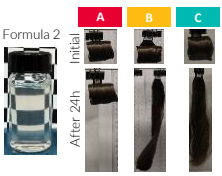


A: Commercial hair gel with PVP fixative B: Commercial hair gel with PVP and Acrylates/Hydroxyesters Acrylates Copolymer fixatives, C: Gel from Table 1 with 5% PVP, D: Gel from Table 1 with 1% HCS, E: Gel from Table 1 with 5% HCS

Curl retention for hair gel formulas with natural rheology modifiers (25°C, 80% RH)

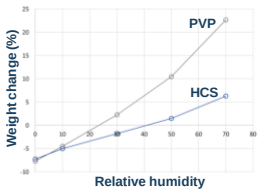


A: Formula 1
B: Formula 1 without HCS
C: Commercial hair gel with Hydroxypropyltrimonium HCS fixative
D: Commercial hair gel with VP/VA Copolymer fixative
E: Tress treated with water



A: Formula 2
B: Commercial hair gel with PVP fixative
C: Tress treated with water

Vapor absorption results



The superior high humidity performance of HCS versus PVP is due to the non-hygroscopic nature of HCS. HCS absorbs significantly less water vapor than PVP under high humidity conditions.

Conclusions:

Hydrolyzed corn starch (HCS) is a 100% bio-based and readily biodegradable hair styling polymer, with excellent clarity in water-based formulas. HCS offers broad formulation compatibility and allows formulators to create clear styling aid compositions with superior hold and humidity resistance compared to synthetic fixatives like polyvinylpyrrolidone. The hair care industry can now meet Consumer expectations for sustainability and performance in hair styling products.

References:

[1] Gleason-Allured J, Grabenhofer RL. Clean Beauty Decoded. Cosmetics & Toiletries. 134(10): 18-25.