WAVEMAX®

Description

Plant-based technology rich in polysaccharide extracted from flaxseed and chia mucilage, providing long-lasting natural curls, and containing bioadhesive capacity, responsible for the immediate sensory improvement in the strands and frizz reduction.

Also available in the **Wavemax® NB** version (with natural benzyl alcohol and COSMOS-certified).

Verified by ECOCERT

COSMOS APPROVED

INCI

Water (and) Linum Usitatissimum (Linseed) Seed Extract (and) Salvia Hispanica Seed Extract.

Introduction

The beauty standards shift brought on by the massive increase in social media over the past two decades has made the single-standard model obsolete, generating diversity in demand for wider niches. The intensity of this change is so great that offering “non-Instagrammable” benefits can make viewers uncomfortable or even disinterested. A closer look at these platforms reveals that most of the images not only feature flawless skin, but also perfectly matched hairstyles. Changes like these, from a new normal and parallel life for millennials on social media, have been driving an aggressive rise in the global hair styling products market.[1]

Data Bridge Market Research shows that the hair care products market grew by USD 21.29 billion in 2021 and is expected to reach USD 29.88 billion in 2029 at a 4.33% CAGR during the 2022-2029 forecast period. These growing innovations have been influencing hair styling products in terms of ingredients and technology. Therefore, the introduction of plant-derived products in the segment has become a differentiating factor in this market.[1]

Those are chemical treatments that can modify hair appearance, from its shape to its color, providing the user with their desired appearance. They act in different ways on its structure, being able to damage and cause structural alterations, including exponentially decreasing tensile strength.[2,3,4] This issue has made room for intermediate products that can provide efficient hair styling without the detriment that permanent transformations usually bring[3,4]. Styling agents, commonly used in conditioners, setting lotions, mousses, and hair sprays, increase the attractive forces between the fibers, helping improve style retention.[5]

Unlike naturally curly hair, with mechanisms that provide possibilities, such as the shape of the follicle in the keratinization zone and the presence of ortho or paracortical cells along the hair cortex, which are altered based on the intersectionality of the hair, where it is known that, for Caucasian hair, mainly the paracortical hairs are found, and afro hair is divided into two zones: orthocortical and paracortical[6,7,8]. Styling agents are deposited on the cuticle and act at a more superficial level, giving the consumer the possibility of a temporary hair change.[6]

One of the most critical aspects for styling is durability, since hair is commonly exposed to varying weather conditions, such as extreme humidity on rainy days, or high relative humidity due to geographic regions. Curl retention, even under high humidity, is therefore an essential test parameter for styling performance, as the hair should not lose its shape under such conditions.[6,7,8]

However, in addition to durability, most consumers are also looking for a build-up free look, in which the hair maintains movement and they can glide their fingers through it while still retaining shape. Therefore, film-forming styling agents cannot be brittle, resulting in loss of style due to manipulation, or even worse, flaking and resulting in noticeable residue on the shoulder and hair, as illustrated in **Figure 1**.[9]

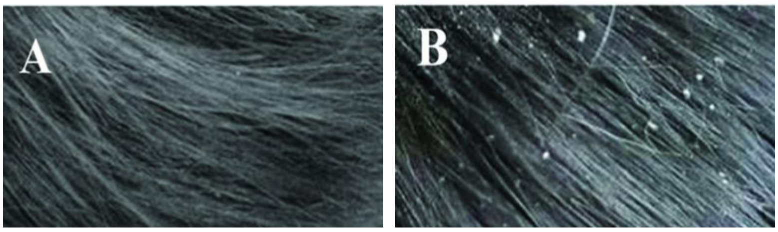

Figure 1: Hair with cracked residues of resistant styling polymers, divided into:
a) Before brushing b) After brushing.[9]

This consumer's growing scrutiny, with demands for long-lasting perfect-looking hair, has brought a series of questions to the traditional market – requiring brands to change their strategies and adapt their formulations by looking for alternatives to these polymers. According to Mintel, recent launches of products with styling agents containing rigid polymers around the world have decreased by 50%. This reduction is also motivated by an increasing search for greener and more effective products.[10]

After analyzing this demand for effective styling products and plant derivatives, **Chemyunion** came up with **Wavemax**® technology. A plant-based active ingredient containing a rich association of polysaccharides extracted from flaxseed (*Linum usitatissimum*) and chia seeds (*Salvia hispanica*), developed to provide the various hair types with the formation and maintenance of natural-looking curls, without compromising its integrity.

Description of the Components

Flaxseed – *Linum usitatissimum*

Flaxseed is obtained from flax (Linum usitatissimum) and belongs to the *Linaceae* family. Its Latin name *Linum usitatissimum* means "very useful," being one of the oldest plants cultivated by man.[11]

Flaxseeds are rich in polyunsaturated fatty acids, in addition to containing significant amounts of protein, dietary fiber, gum or mucilage, phenolic compounds, vitamins, and minerals, according to the literature. These substances found in the seeds have important biological properties, providing beneficial effects to human health, being widely used in the food industry and arousing interest in the use as a cosmetic ingredient.[12,13]

Figure 2: Flaxseed - *Linum usitatissimum*

Among the various substances found in flaxseed is a high content of soluble dietary fiber which, due to the high hydration capacity and strength of the formed gel, is traditionally called gum or mucilage, and represents approximately 8% of the weight of the seed.[14]

When in contact with water, flaxseed exudes a transparent, polysaccharide-rich mucilaginous gel, which remains firmly attached to the seed, often being difficult to separate (**Figure 3**).

The mucilage is formed by xylose, arabinose, glucose, galactose, galacturonic acid, rhamnose, and fucose[8]. It has weak gel properties and can be used to replace most non-gelatin gums. Because it does not have a charge, it has a high potential for compatibility with most excipients and cosmetic ingredients.[15,16]

The gum extracted from this seed can become a highly valuable technological product in the food and cosmetics industry, especially due to its excellent potential as a gel-forming hydrocolloid, due to its remarkable ability to undergo hydration (swelling), form a film and due to its high viscosity in aqueous solutions.[15]

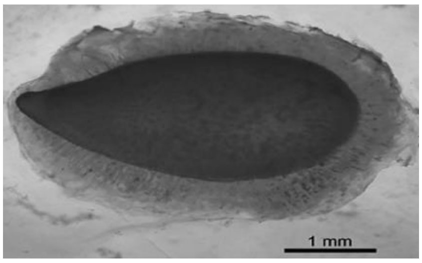

Figure 3: Image illustrating the mucilage formed around flaxseed.[17]

Chia seed - *Salvia hispanica*

Salvia hispanica, popularly known as chia, is a herbaceous plant of the *Lamiaceae* family that grows in arid or semi-arid regions and produces seeds with a high protein content.[18]

Figure 4: Chia seed - *Salvia hispanica*

As with flaxseed, when chia seeds are soaked in water, a clear, mucilaginous gel that remains firmly attached to the seed is exuded (**Figure 5**). This mucilage corresponds to a polysaccharide with a high molecular weight and has a water retention capacity of up to 27 times its weight.[18]

Chia mucilage is a branched polysaccharide composed essentially of xylose, glucose, and glucuronic acid, and despite its great potential for food applicability, there is a lack of studies of its application in other areas, such as the cosmetic industry.[18,19,20]

Chia mucilage arrives as a new source of polysaccharide, with the potential to generate different films and coatings with improved properties, and represents about 5% to 6% of the chia seed. The association between the different components of the chia mucilage forms a network structure that offers interesting rheological properties.[21,22]

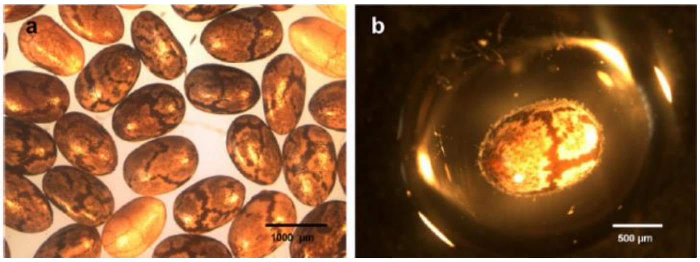

Figure 5: Image illustrating dried chia seed (a) and the mucilage formed around it in water (b).

Mode of Actions:

The chia and flax seeds in **Wavemax**®, when in contact with water, form a polysaccharide-rich mucilage around them. These, in turn, are soluble, but when applied to the hair fiber, form a film with bioadhesive adherent properties.

Figure 6: Illustration of the mechanism of deposition of Chia and Flaxseed polysaccharides of **Wavemax**® on the hair fiber

Through intermolecular interactions of hydrogen bonds between the hydroxyl (OH-) groups present in the polysaccharides, this process corroborates with the polar side groups containing hydroxyl (OH-) and amino (-NH2) groups of the amino acids present in the chemical structure of keratin.

Benefits

- Curl retention for up to 24 hours;
- Hair volume control for up to 24 hours;
- Decreased *frizz* formation from the first application;
- Natural, long-lasting hair modeling effect;
- Flexible, long-lasting curls, free from the "false dandruff" effect;
- Hair curls formation by using the hands alone. Catalyzed effect with curling iron;
- Plant-based alternative to synthetic styling polymers.

Tests

Ex Vivo Efficacy – Evaluation in Hair Locks

1. Evaluation of curls formation in hair locks.

Methodology: Locks were conditioned at a relative humidity of 50±5 and a temperature of 23±2 °C, for 24 hours, before the tests were started. The evaluation of curl retention was determined using the RUMBA equipment (Bossa Nova Technologies, USA). Measurements were taken before and after treatment, in a controlled environment. After that, the same analysis was performed after 2 h, 6 h, and 12 h of the treatment, to evaluate styling maintenance.

Treatment: The treatments were performed according to the laboratory's standard protocol and the groups were segregated into:

Control: No treatment.

Placebo: Treatment with shampoo and leave-on product with no active ingredient.

Wavemax®: Treatment with active ingredient-free shampoo and leave-on product at 3% **Wavemax®**.

Benchmark: Treatment with active ingredient-free shampoo and leave-on product at 3% Benchmark.

Benchmark 1: Treatment with active ingredient-free shampoo and leave-on product at 3% Benchmark 1.

After the treatments, the locks of all groups were modeled with curling iron at 210 °C for 30 seconds and analyzed afterwards.

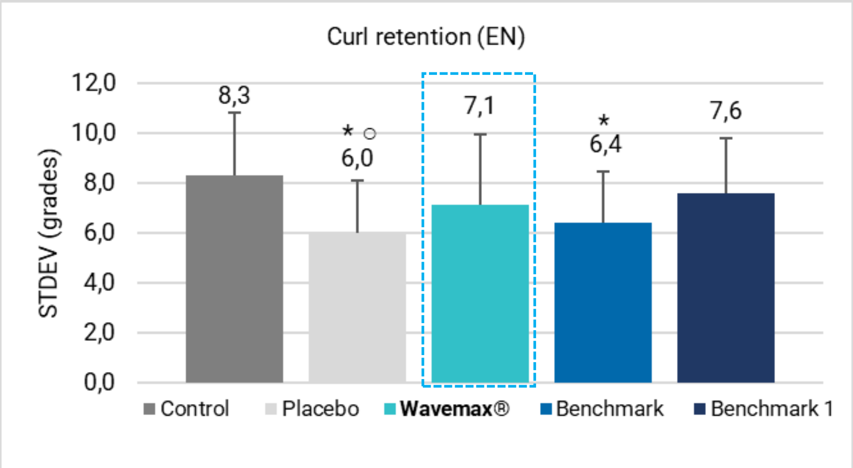

Figure 7: Graph of curl retention evaluation (STDEV) of the control, placebo, **Wavemax®**, Benchmark, and Benchmark 1 groups, right after modeling with a curling iron.

* Significant difference compared to the Control group (p = 0.0010; p = 0.0070)
○ Significant difference compared to the Benchmark 1 group (p = 0.0133)

The Control group (G1) showed STDEV values (index referring to the curl retention capacity) significantly higher than the Placebo (G2) and Benchmark (G4) groups. The group treated with Benchmark 1 (G5) showed a significantly higher STDEV value when compared to the Placebo group (G2). Control group (G1) showed the highest STDEV values due to the fact that the locks were not treated with a leave-on formulation, causing the curls formed immediately after using the curling iron to become more defined, due to the lower malleability of these hair fibers.

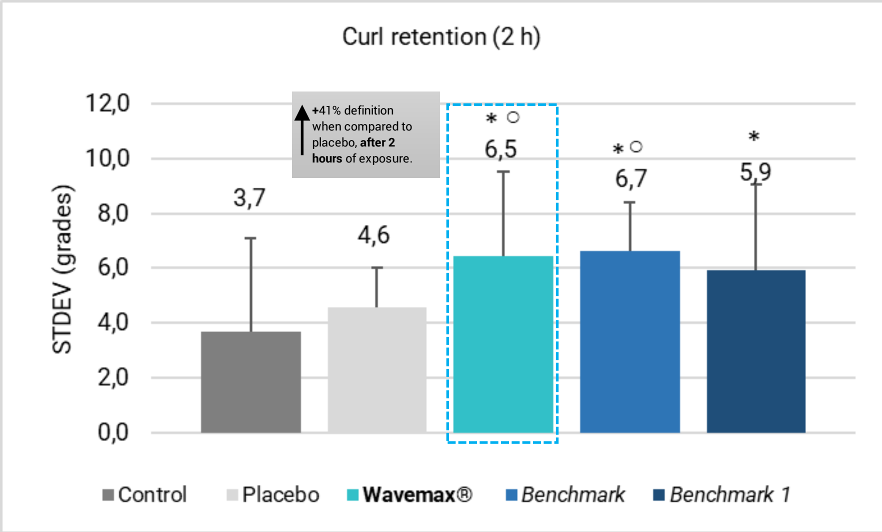

Figure 8: Graph of curl retention evaluation (STDEV) of the control, placebo, **Wavemax®**, Benchmark, and Benchmark1 groups, 2 hours after modeling with a curling iron.

* Significant difference compared to the Control group ($p = 0.0046$; $p = 0.0006$; $p = 0.0209$)
○ Significant difference compared to the Placebo group ($p = 0.0098$; $p < 0.0001$)

Figure 8 shows that the group treated with **Wavemax®** had 41% more definition, even after exposure to high humidity for 2 hours, when compared to the placebo group.

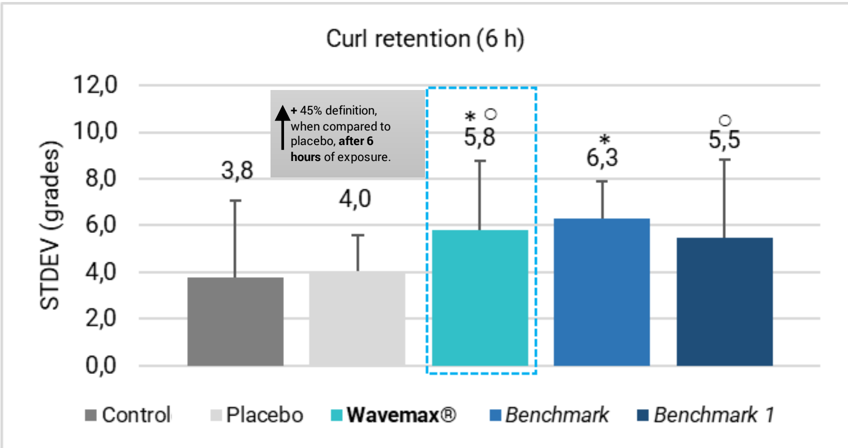

Figure 9: Graph of curl retention evaluation (STDEV) of the control, placebo, **Wavemax®**, Benchmark, and Benchmark1 groups, 6 hours after modeling with a curling iron.

* Significant increase compared to the Control group ($p = 0.0285$; $p = 0.0020$)
○ Significant increase compared to the Placebo group ($p = 0.0144$; $p < 0.0001$)

Figure 9 shows that the group treated with **Wavemax®** had 45% more definition, even after exposure to high humidity for 6 hours, when compared to the placebo group.

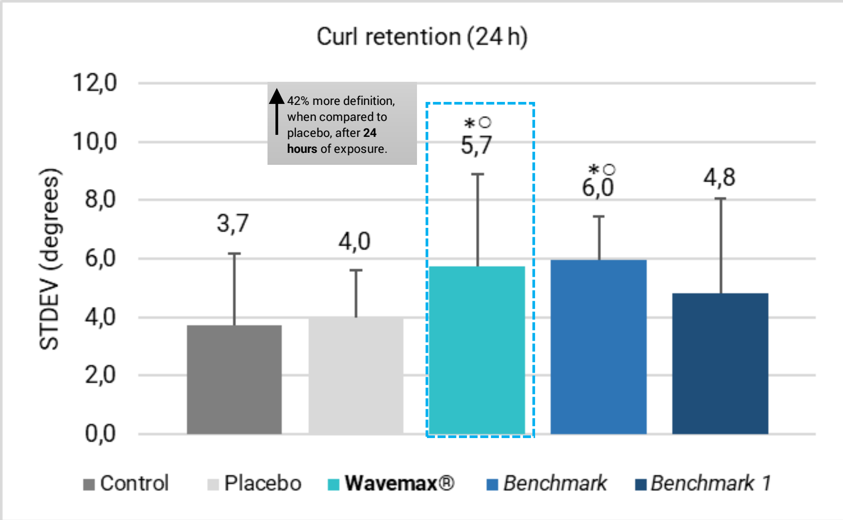

Figure 10: Graph of curl maintenance evaluation (STDEV) of the control, placebo, **Wavemax**®, Benchmark, and Benchmark 1 groups, 24 hours after modeling with a curling iron.

* Significant increase compared to the Control group (p = 0.0189; p = 0.0005)
○ Significant increase compared to the Placebo group (*p* = 0.0212; *p* < 0.0001)

Figure 10 shows that the group treated with **Wavemax**® had 42% more definition, even after exposure to high humidity for 24 hours, when compared to the placebo group. **Wavemax**®'s ability to retain curls is further evidenced by the images obtained with the Rumba equipment (**Figure 11**).

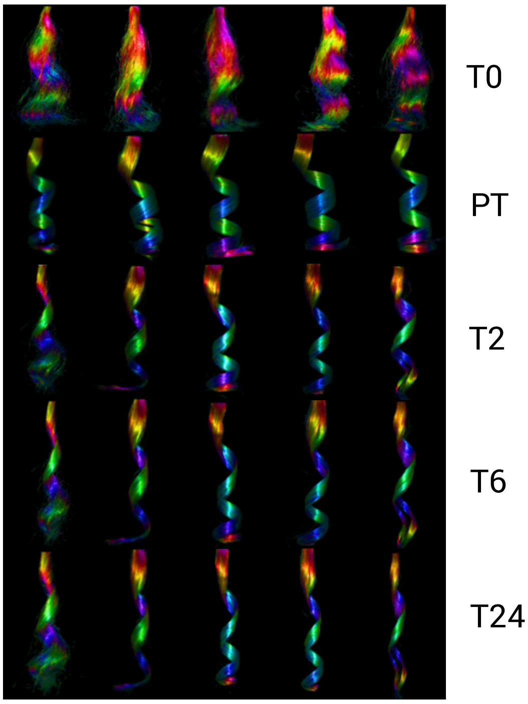

Figure 11: Color-coded images representing variations in curl orientation angles at different time points (T0 = Before treatment; T2 = 2 hours after treatment; T6 = 6 hours after treatment, and T24 = 24 hours after treatment), as captured by the Rumba equipment. **Wavemax**®'s performance was evaluated by its curl shape-retention capability in up to 24 hours, when compared to the Control, Placebo, Benchmark, and Benchmark 1 groups.

2. Frizz Evaluation in Hair Locks

Methodology: Locks were conditioned at a relative humidity of 50±5 and a temperature of 23±2 °C, for 24 hours, before the tests were started. Frizz evaluation was determined using the RUMBA equipment (Bossa Nova Technologies, USA). Measurements were taken before and after treatment, in a controlled environment. After that, the same analysis was performed after 2 h, 6 h, and 12 h of the treatment, to evaluate the frizz.

Treatment: The treatments were performed according to the laboratory's standard protocol and the groups were segregated into:

Control: No treatment.

Placebo: Treatment with shampoo and leave-on product with no active ingredient.

Wavemax®: Treatment with active ingredient-free shampoo and leave-on product with 3% **Wavemax®**.

Benchmark: Treatment with active ingredient-free shampoo and leave-on product with 3% Benchmark.

Benchmark 1: Treatment with active ingredient-free shampoo and leave-on product with 3% Benchmark 1.

After the treatments, the locks of all groups were modeled with curling iron at 210 °C for 30 seconds and analyzed afterwards.

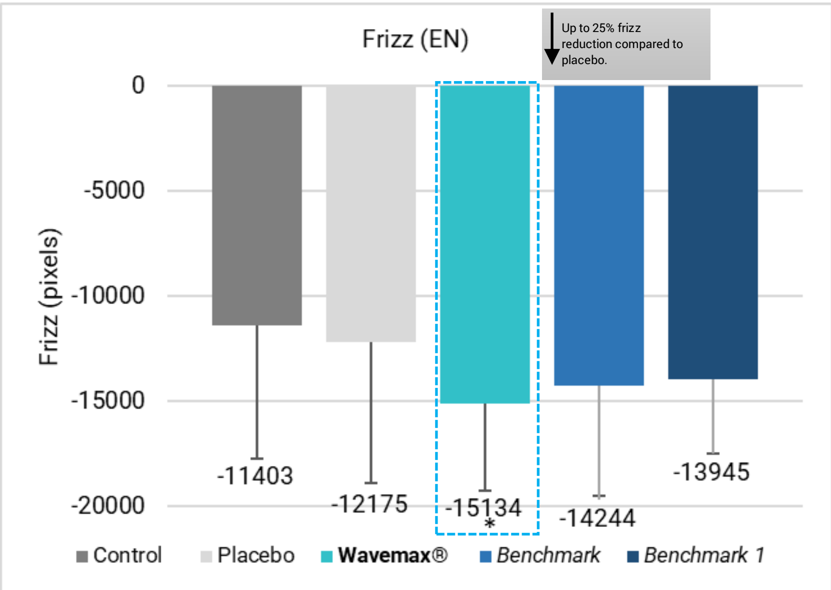

Figure 12: Frizz evaluation graph (pixels) of the control, placebo, **Wavemax®**, Benchmark, and Benchmark 1 groups, right after modeling with a curling iron.

* Significant reduction compared to the Control group (p = 0.0219)

Figure 12 shows that treatment with **Wavemax®** results in an immediate decrease in frizz of approximately 25% when compared to the placebo group.

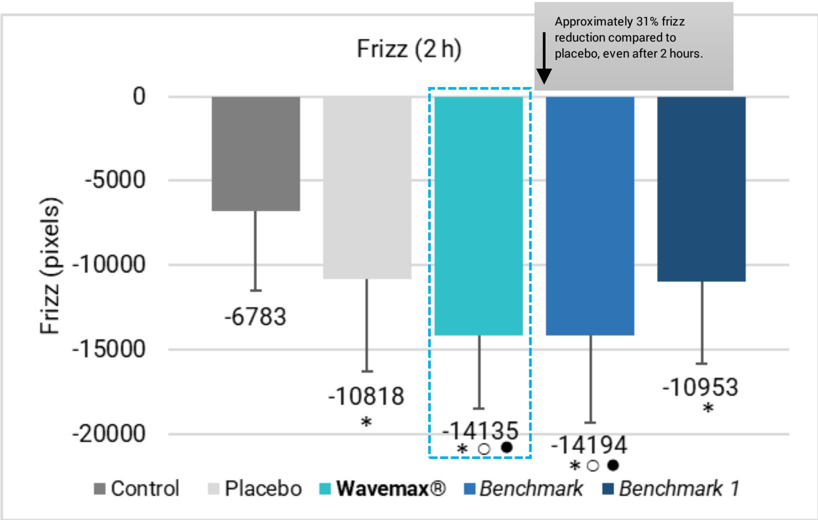

Figure 13: Frizz evaluation graph (pixels) of the control, placebo, **Wavemax**®, Benchmark, and Benchmark 1 groups, 2 hours after modeling with a curling iron.

* Significant reduction compared to the Control group ($p = 0.0096$; $p < 0.0001$; $p = 0.0047$)
○ Significant reduction compared to the Placebo group ($p = 0.0309$; $p = 0.0351$)
● Significant reduction compared to the Benchmark 1 group ($p = 0.0269$; $p = 0.0325$)

Figure 13 shows that treatment with **Wavemax**® results in an immediate decrease in frizz of approximately 31% when compared to the placebo group, even after 2 hours of exposure.

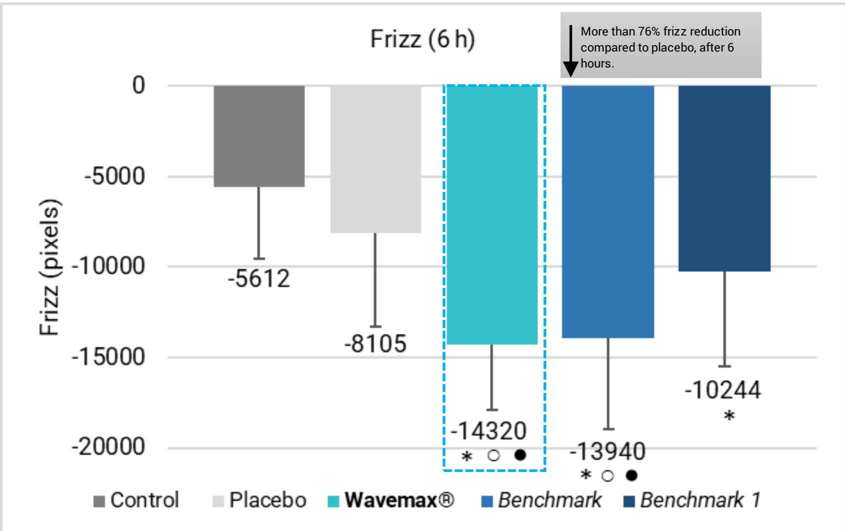

Figure 14: Frizz evaluation graph (pixels) of the control, placebo, **Wavemax**®, Benchmark, and Benchmark 1 groups, 6 hours after modeling with a curling iron.

* Significant reduction compared to the Control group ($p < 0.0001$; $p = 0.0013$)
○ Significant reduction compared to the Placebo group ($p < 0.0001$; $p = 0.0003$)
● Significant reduction compared to the Benchmark 1 group ($p = 0.0269$; $p = 0.0325$)

Figure 14 shows that treatment with **Wavemax**® results in an immediate decrease in frizz of approximately 76%, even after 6 hours of exposure.

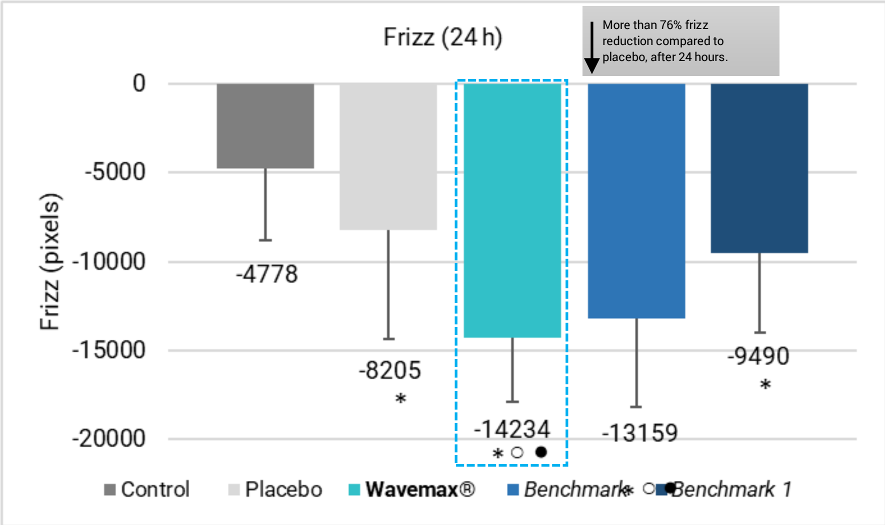

Figure 15: Frizz evaluation graph (pixels) of the control, placebo, **Wavemax®**, Benchmark, and Benchmark 1 groups, 24 hours after modeling with a curling iron.

* Significant reduction compared to the Control group (p = 0.0309; *p* < 0.0001; p = 0.0004)
○ Significant reduction compared to the Placebo group (*p* = 0.0003; *p* = 0.0041)
● Significant reduction compared to the Benchmark 1 group (p = 0.0003; p = 0.0113)

Figure 15 shows that treatment with **Wavemax®** results in an immediate decrease in frizz of approximately 73% when compared to the placebo group, even after 12 hours of exposure.

3. Evaluation of Hair Fiber Relief by Scanning Electron Microscopy

Methodology: The evaluation of the hair fiber relief was performed using a Scanning Electron Microscope (SEM), 6460LV (JEOL). The study comprised the collection of images of secondary electrons, samples of hair strands from the groups treated with a 3% solution of **Wavemax®** and a second untreated group (control) collected randomly.

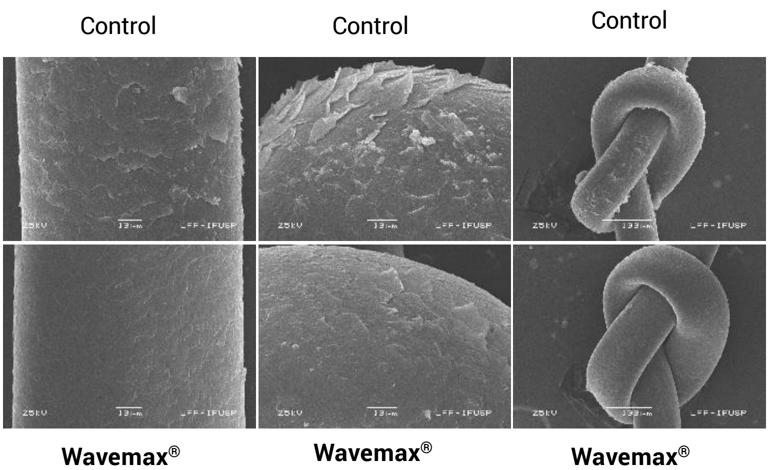

Figure 16: Scanning Electron Microscopy (SEM) in natural hair locks, where the control and **Wavemax®** groups were analyzed, right after treatment at different angles.

The images obtained by SEM show that the hair samples treated with 3% **Wavemax®** had closed and preserved cuticles, indicating the formation of a film on the hair fiber, which provides sensory improvement. While in the Control Group images, a large number of open cuticles was observed.

Application

Shampoos, conditioners, hair masks, and leave-on products in general.

Stability and Compatibility

Compatible with ionic, cationic, and non-ionic bases. Soluble in water.

Concentration of Use

1-5% (w/w)

References

1- Data bridge Market Research – Available at <https://www.databridgemarketresearch.com/reports/global-hair-styling-products-market >

2- BOLDUC, C.; SHAPIRO, J. Hair Care Products: Waving, Straightening, Conditioning, and Coloring. Clinics in Dermatology, v.19, p.43-436, 2001.

3- MALYSSE, S.R. Opus Corpus, Antropologia das aparências: pesquisa sobre megahair e os usos sociais do cabelo, 2001. Available at Accessed on March 31, 2021.

4- Syed, A.N. and Ayoub, H. Correlating porosity and tensile strength of chemically modified hair. Cosmetics & Toiletries magazines, Vol. 117, No. 11, November 2002.

5- ROBBINS, C.R. Chemical and Physical Behavior of Human Hair - Springer-Verlag Berlin Heidelberg, 4th Edition. - Style Retention and Hair Treatments. p446.

6- ROBBINS, C.R. Chemical and Physical Behavior of Human Hair - Springer-Verlag Berlin Heidelberg, 4th Edition. - Morphological and Macromolecular Structure. p48.

7- J A Swift. Fundamentals of human hair science, 1st Issue, Micelle Press, 1997.

8- R Dawber. Hair: Its structure and response to cosmetic preparations, Clinics in Dermatology 14 (1): 105-112, 1996.

9- Musa, O. M., & Tallon, M. A. (2013). Hair Care Polymers for Styling and Conditioning. Polymers for Personal Care and Cosmetics, 233–284.

10- Mintel, GNPD – Accessed on October 21, 2022. Available at < https://www.gnpd.com/sinatra/analysis/chart_results/search/j0KKdUhG9v/?analysis_id=66162252-4bc4-4a84-8ff3-3e2c80b204eb&current_tab=66162252-4bc4-4a84-8ff3-3e2c80b204eb>.

11- OOMAH, B. D.; DER, T. J.; GODFREY, D.V. Thermal characteristics of flaxseed (Linum usitatissimum L.) proteins National BIoproducts and Bioprocesses Program, Pacific Agri-Food Research Centre and Agri-Food Canada. Food Chemistry. V.98, p.733-741, 2006.

12- OOMAH, B. D.; MAZZA,G. Productos de linaza para la prevencion de enfermedades. In: MAZZA, G. (Ed.) Alimentos Funcionales. Zaragoza – Espana: Acribia S.A., 2000. Cap.4, p.93-140.

13- GALV‹O, Elisangela Lopes et. al. Avaliacao do potencial antioxidante e extracao subcritica do oleo de linhaca. Ciencia e Tecnologia de Alimentos, Campinas – Brazil, p.551-557, Sep. 2008.

14- WANNERBERGER, K.; NYLANDER, T.; NYMAN, M. Rheological and chemical properties of mucilage in different varieties from linseed (Linum usitatissimum L.). Acta Agriculturae Scandinavica, Sweden. V.41, n.3, p.311-319. 199.

15- CHEN, Hai-Hua; XU, Shi-Ying; WANG, Z. Interaction between flaxseed gum and meat protein. Journal of Food Engineering, Essex, v.80, n.4, p.1051-1059, Jun. 2007. - 14

16- CUI, W.; MAZZA, G. Physicochemical characteristics of flaxseed gum. Food Research International, v.29, n.3-4, p.397-402, 1996.

17- ZIOLKOVSKA, A., Laws of flaxseed mucilage extraction, Food Hydrocolloids. n.26, n.1, p.197-204, 2012.

18- LIN, K. Y.; DANIEL, J. R.; WHISTLER, R. L. Structure of chia polysaccharide exudates. Carbohydrate Polymers, v.23, p.13-18, 1994.

19- MUNOZ, L.A.; AGUILERA, J.M.; RODRIGUEZ-TURIENZO, L.; COBOS, A.; DIAZ, O. Characterization and microstructure of films made from mucilage of Salvia hispanica and whey protein concentrate. Journal of food Engineering, v.11, p.511-518, 2012.

20- REYES-CAUDILLO, E.; TECANTE, A.; VALDIVIA-LŁPEZ, M.A. Dietary fibre content and antioxidant activity of phenolic compounds present in Mexican chia (Salvia hispanica L.) seeds. Food Chemistry, v.107, p.656-663, 2008.

21- REYES-CAUDILLO, E.; TECANTE, A.; VALDIVIA-LŁPEZ, M.A. Dietary fibre content and antioxidant activity of phenolic compounds present in Mexican chia (Salvia hispanica L.) seeds. Food Chemistry, v.107, p.656-663, 2008.

22- PHILIPS, G,O.; WILLIAMS, P.A. Introduction to food hydrocolloids, In: Philips, G.O., Willians, P.A. (Eds.) Handbook of Hydrocolloids. Cambridge, England: Woodhead Publishing Limited, 2000.

SA: 14430/21