J. Cosmet. Sci., **58**, 405–411 (July/August 2007)

New keratin isolates: Actives for natural hair protection

ALISA RODDICK-LANZILOTTA, ROB KELLY,
SONYA SCOTT, and SURINDER CHAHAL, *Canesis Network Ltd, Private Bag 4749, Christchurch, New Zealand (A.R.-L., S.S.), Keratec Limited, Springs Road, Lincoln, Canterbury, New Zealand (R.K.), and Croda Chemicals Europe, Cowick Hall, Snaith Goole, East Yorkshire DN14 9AA, U.K. (S.C.).*

Synopsis

Hair is primarily composed of keratin proteins and it is well established that peptides and proteins bestow desirable effects on the hair, for example improving moisturization and softness. In the present work we describe how keratin actives with unique properties convey a range of beneficial properties to a variety of hair types. It has been observed that these functional keratins protect hair from damage associated with chemical treatments such as perming and relaxation, help to restore the mechanical strength of damaged fibers and decrease fading of colored hair.

INTRODUCTION

It is well known that proteins have beneficial effects on hair. For a long time it has been acknowledged that hydrolyzed proteins, convey desirable effects to hair care formulations, improving, softness, moisturization and leaving hair feeling and looking healthier. Hair is primarily composed of keratin protein, one of nature's most successful materials. Many of the commercially available keratin ingredients have been manufactured using harsh processes which destroy the natural functionality of the keratin and yield low molecular weight peptides.

In order to fully capitalize on the properties of keratins, an approach which allows the natural characteristics of the materials to be maintained is needed. In this paper, we describe how a new range of "Functional Keratins," which have been created by using patented technologies, protect the hair. The origin of this protective effect is attributable to the isolation of intact protein fractions which leads to unique amino acids combinations and film-forming properties of the high molecular weight (~55kD) water soluble portion. In addition, they possess a unique s-sulpho functionality, which conveys anti-oxidant properties and allows them to react with hair to permanently attach. This is particularly relevant when hair is damaged and in the presence of chemicals used during typical chemical treatments, such as perming and relaxation.

In previous reported studies, these new actives have been shown to convey anti-aging properties to hair by protecting the fiber cortex and surface from damage arising from sunlight and urban pollution (1–3). Here we describe how these actives convey other beneficial properties to a variety of hair types, for example, protecting hair from damage associated with chemical treatments, such as perming and relaxation, helping to restore the mechanical strength of damaged fibers and decreasing fading of colored hair.

MATERIALS AND METHODS

HAIR SOFTNESS

Tresses (~3g) were prepared from Natural Red Hair (20 cm, De Meo Bros.) by weighing ~3.3g of hair from the pigtail supplied and fixing with a cable tie approximately 2.5 cm from the butt end. The butt end was then glued using Ados F2 adhesive and once it was dry the unstuck hair was removed carefully by combing. A conditioner formulation (3g) with or without the functional keratin ingredient (1%), was applied to the hair tresses, worked through and left for two minutes. Hair was rinsed under a steady stream of water at 40°C for two minutes. Each of the tresses was reproducibly combed using 10 strokes using of the tensile tester (Instron 4204) with a combing attachment. Tresses were allowed to air dry prior to panel assessment.

A panel testing with 12 judges was used to evaluate the sensorial properties of the treated hair tresses. The tests were performed in a conditioned room (20°C, 60%RH), where all hair tresses (untreated and treated) were compared in pairs and volunteers were asked the question "which hair tress is softer?" All results were then subjected to statistics analysis. A Spearman's Rank Correlation Coefficient was used to investigate the level of agreement between the judges and the Chi-Square Test was used to investigate the uniformity of the distribution of the volunteer's answers.

HAIR BREAKAGE

3g hair tresses (Asian, from De Meo Bros.) were prepared and pre-combed wet. Conditioner formulation (3g) with or without the ingredient, was applied to the hair tresses and worked through. Hair was rinsed under a steady stream of water at 40°C for two minutes. Tresses were allowed to dry prior to being combed manually for 1600 strokes with a fine toothed plastic comb. Broken fibers were collected and counted after 400 strokes and then after a further 1200 combing strokes.

PROTECTION DURING HAIR RELAXATION

Volunteers of African decent were recruited for the experiment. A half head test protocol was used. Samples of the hair (approximately 30 mm in length) were taken prior to relaxation and then the whole head of hair was relaxed using a standard hydroxide relaxing system. Following relaxation and physical lengthening, a 4% aqueous solution (as supplied) of functional keratin was applied to one half of the head only. Neutralization and washing was then carried as usual. Samples of the hair from each side of the head were taken and sent for SEM analysis. 20 fibers from each sample were mounted on a 20 mm stub and coated for SEM observation. Representative micrographs were recorded and the overall features of the samples were summarized.

POSTTREATMENT OF RELAXED HAIR

Lithium relaxer cream (0.4g) was applied to the afro hair switch (0.1g) and massaged in until it was well covered. The cream was left for 20 minutes and tension was applied by massaging 10 times at 5 minute intervals. The hair was rinsed in water at 40°C for 2 minutes. The switch was then washed with 0.4g of neutralizing shampoo and rinsed. The switch was either left in water (control) or placed in an aqueous solution of 1% functional keratin (as supplied) for 2 minutes, rinsed and allowed to dry overnight.

Mechanical testing was carried out on 50 hair fibers randomly sampled from each of the switches. Fibers were wet for at least 30 minutes prior to measurement. Each fiber was placed in the grips of the tensile tester (Instron 4204). Individual hair fibers were extended at a constant rate (100%/min) until rupture and the force was recorded.

COLOR PROTECTION

Virgin human hair (De Meo, natural red) was dyed with Colour Cream and developer Perfectone 66/46 Cherry Red (Wella) using the procedure described on the packet. All hair was dyed together according to the instructions (12.5g of color cream was mixed with 10g of color cream developer). The mixture was applied to the hair, completely covering the sample and left for 30 minutes for color development. The hair was then washed in 40°C water until no further color washed out. The hair sample was air dried and separated into 3g tresses.

The treatment conditions were: Control—dyed and exposed UV light and washing. Keratin treated—dyed, treated with a conditioner base containing 1% functional keratin (using a rinse-off protocol) prior to exposure to UV light, and washing. Conditioner base treated—dyed, treated with conditioner base prior to UV light exposure, and washing.

All tresses were washed prior to and following 24 hrs of UV exposure (MBTF 1000W lamp in a light box). Conditioner with 1% functional keratin or the base was applied prior to each 24 hr UV exposure, using a rinse off protocol. 24 hours of UV is the equivalent to ~10 days of New Zealand summer sunlight. The application, UV, washing procedure was repeated 3 times to give a total of 72 hrs of UV light exposure. L*a*b* measurements were made at each 24 hr interval.

RESULTS AND DISCUSSION

HAIR SOFTNESS

Moisture is a significant factor in hair softness. Dry hair is brittle, and feels coarse compared with soft hair which has greater flexibility and can accommodate bending and extension more easily. Panel assessment involving 12 volunteers showed that addition of functional keratin to a conditioner gave hair a softer feel (see Figure 1). This increase in softness arises from ability of the functional keratin to protect the natural structure of the hair, and in doing so assist the hair in retaining moisture.

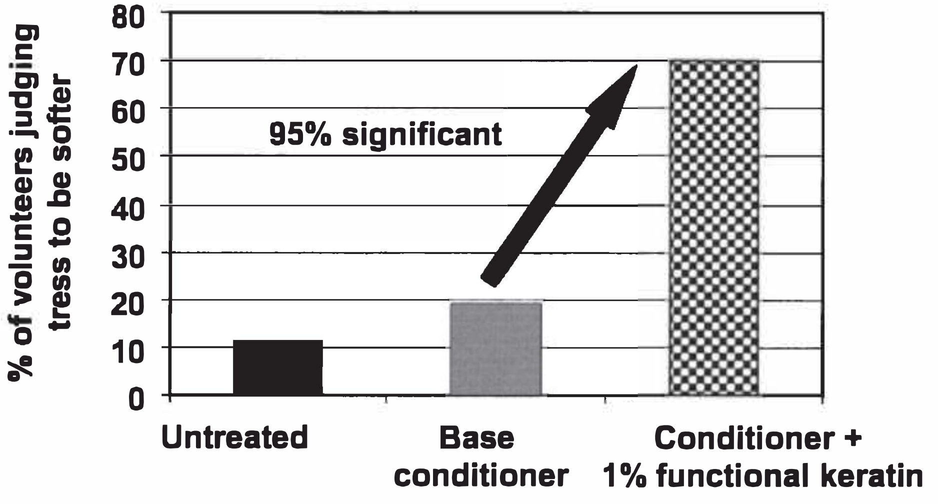

Figure 1. Graph showing the results of a volunteer panel assessment of hair softness comparing untreated, base conditioner treated and conditioner plus 1% functional keratin treated hair tresses.

HAIR BREAKAGE

Hair breakage results from the deterioration of the fiber structure and poor grooming practises. Hair tresses either untreated, or conditioner treated with and without keratin, were prepared and repeatedly combed, as described in the methods section. Only a small amount of breakage was found after the first 400 strokes, with 16 fibers counted for the water control, 10 for the conditioner formulation and 7 for the conditioner plus the functional keratin, indicating that the hair used was in a relatively undamaged state. A further 1200 strokes were performed to stress the hair. The total number of fibers broken for each condition is summarized in Figure 2. Following this protocol it was found that

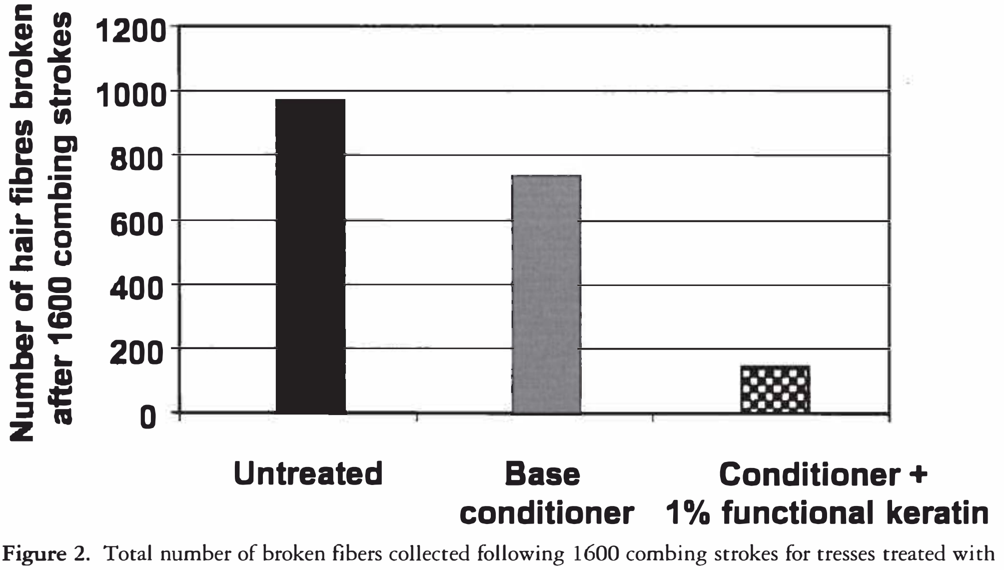

Figure 2. Total number of broken fibers collected following 1600 combing strokes for tresses treated with water (control), base conditioner, and conditioner plus 1% functional keratin.

the control hair tress treated with water only gave the greatest amount of fiber breakage with 967 broken fibers being collected during 1600 combing strokes. Hair treated with the base conditioner formulation yielded 736 broken fibers. Treatment with the formulation plus 1% functional keratin gave substantially less breakage with only 144 broken fibers being collected during the 1600 combs.

PROTECTION DURING HAIR RELAXATION

Relaxation and neutralizing treatments lead to hair damage, observable by scanning electron microscopy (SEM) as disruption to the cuticle structure of the surface. SEM examination of virgin hair (prior to relaxation), relaxed hair and relaxed hair with a keratin treatment step prior to neutralization, showed that keratin application appeared to leave deposits on the fiber surface and prevent significant disruption to the fiber structure. Keratin treated fibers were much more similar in appearance to virgin hair than those that did not receive the same treatment (Figure 3). The mechanism for this protection from damage may include interaction of the keratin with both the internal structure and the external surface of the fiber. The high pH regime of relaxation opens the keratin structure significantly, swelling the fiber and allowing ingress of keratin in during the post treatment. Subsequent low pH treatment may then lock the applied protein in place, protecting the hair's protein from the damaging treatment and manifesting as maintenance of surface structure and ultimately fiber health.

POSTTREATMENT OF RELAXED HAIR

In a further experiment, a study was undertaken to investigate the reparative effect of functional keratin when applied as a posttreatment on afro hair relaxed with a conventional lithium based relaxer system. Results, summarized in Table I, showed that post treatment with 1% functional keratin solution following relaxation significantly increased the energy to extend the wet hair fibers by 20% and the total energy and also improved the overall average strength of the fibers.

COLOR PROTECTION

Fading of colored hair occurs from a combination of UV induced decomposition of the dye and wash out. Hair was dyed red, either left untreated, or treated with a conditioner base with and without the keratin ingredient (as described in the methods section) and then submitted to a regime of UV exposure and washing. It was found that there was a decreased amount of fading observed after 10, 20 and 30 days of sunlight exposure, as observed by a lower (more negative) value for change in lightness. Figure 4 shows the results following the equivalent of 20 days of sunlight exposure and two surfactant washes.

CONCLUSIONS

A new range of functional keratins which are highly efficacious have been developed. These ingredients have innate protective and restorative properties when applied to hair

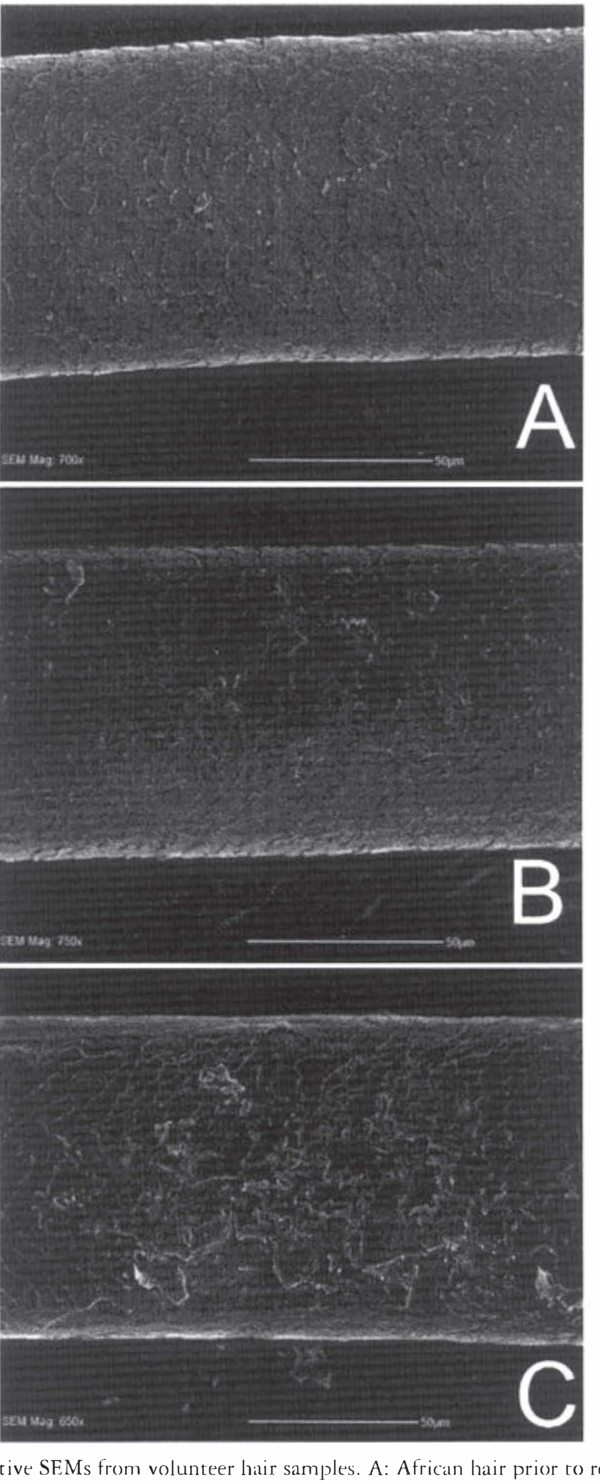

Figure 3. Representative SEMs from volunteer hair samples. A: African hair prior to relaxation, B: African hair following relaxation, treatment with functional keratin and the neutralization, C: Africa hair following relaxation and neutralization.

Table I
Results of Tensile Measurements of African Hair from Volunteers Following Relaxation, with and without a Posttreatment of 1% Functional Keratin

Measured parameter (N=50)	Relaxed hair	Relaxed hair posttreated with 1% functional keratin	Students *t*-test (*p*) (compared with relaxed hair)
Energy at 20% extension ($\times 10^{-5}$J)	52.6	62.6	0.003
Total energy ($\times 10^{-5}$J)	126.0	147.0	0.017
% Extension at peak	38.6	37.6	0.349
Average strength at peak (gF)	27.3	30.0	0.074

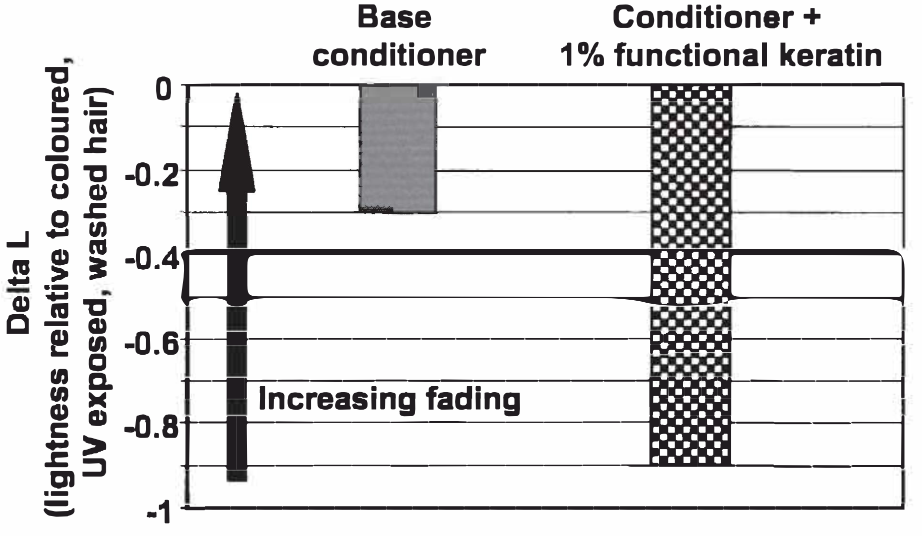

Figure 4. Amount of fading of tresses, determined by change in lightness relative to non-conditioner treated hair, after the equivalent of 20 days of New Zealand sunlight.

which arise from their reversibly protected (s-sulpho) cystine groups, film forming properties and novel amino acid composition. They are suitable for hair care formulations targeted at anti-aging, environmental protection, color protection, protection during chemical treatments, and restoration of chemically and environmentally damaged hair.

REFERENCES

(1) A. D. Roddick-Lanzilotta, R. J. Kelly, S. M. Scott, K. Mitchell, and S. Chalal, Protecting hair with natural keratin biopolymers, *Cosmet. Toiletr.,* 121(5) 61–68 (2006).
(2) A. D. Roddick-Lanzilotta, R. J. Kelly, S. M. Scott, S. Chahal, and N. Challoner, Measurement and prevention of hair photoageing, *J. Cosmet. Sci.,* 55 (Suppl), S113–121 (2004).
(3) A. D. Roddick-Lanzilotta, R. J. Kelly, S. M. Scott, S. Chahal, and N. Challoner, Anti-ageing efficacy in hair care products, *SOFW Int. J. Appl. Sci.,* 11 (2004).