Exploring the power of upcycled tamarind

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ABSTRACT

Cationic polymers are important components especially in hair care, providing ease of combing and sensory benefits. With sustainability becoming essential for personal care ingredients, conventional and naturally-derived conditioning polymers often lack biodegradability, while most natural alternatives underperform. To address this, Lamberti has developed Esaflor® T. Obtained from the seeds of *Tamarindus indica L.*, a byproduct of the food industry, this novel polymer combines performance in line with market requirements, ready biodegradability and upcycled origin from renewable resources. This article describes its benefits in hair care, including superior conditioning, detangling, shine, smoothness, softness, anti-static effects, and foam-enhancement, comparing the novel tamarind derivative to Polyquaternium-10.

Cationic polymers are essential components in conditioners and conditioning shampoos, providing ease of combing and contributing to a positive sensory experience. With sustainability becoming a key factor in ingredient selection due to eco-conscious consumers and recent regulatory requirements, conventional synthetic and naturally-derived polymers often lack biodegradability. Natural alternatives, meanwhile, frequently fail to meet consumers' performance expectations.

Addressing this unmet need, Lamberti embraced the challenge to engineer an advanced, sustainable solution. The journey started with a deep investigation of the class of hydrocolloid derivatives, followed by a meticulous fine-tuning of their properties through chemical modification.

This research culminated in the development of a novel quaternized carboxymethyl tamarind (QCT): Esaflor® T. This innovative ingredient meets market performance standards, offers ready biodegradability, and comes from upcycled renewable resources.

Tamarind tree: a botanical treasure

At the heart of this innovation is tamarind. *Tamarindus indica L.* is an evergreen tree, moderate to large in size, belonging to family Leguminosae (Fabaceae). Today, it flourishes in tropical and subtropical regions, with India and Thailand being the leading tamarind world producers.

T. indica is known for its delicious appetising fruit, with the soft pulp used in a variety of culinary creations like chutneys, sauces, sweets, and beverages. Beyond its food applications, tamarind has long been valued for its multifaceted uses.

Several parts of the tree—such as pulp, roots, wood, bark and leaves —are employed across various industries, including pharmaceuticals, and can contribute to the development of green and sustainable products. Traditionally used in Ayurvedic medicine, for instance, tamarind continues to be a valuable remedy for various ailments, due to its antidiabetic, antimicrobial, and antioxidant properties.[1]

Tamarind seed polysaccharide: an upcycled ingredient

Although the pulp is the most valuable part of tamarind, thanks to its pleasant flavour and nutritional benefits, it makes up only 30–50% of the ripe fruit. The remainder consists of the shell and fibre (11–30%) and seed (25–40%).[2] The seeds, however, are considered as byproducts and are often discarded, leading to significant waste.[3]

Despite this, they are a hidden gem. They contain a large amount of polysaccharides, with tamarind seed polysaccharide (TSP), also known as tamarind gum, being the most abundant. TSP is a neutral xyloglucan composed of a β-(1,4)-d-glucan backbone carrying α-(1,6)-d-xylose and β-(1,2)-d-galactose substituents in a molar ratio of 3.1:1.7:1 (Figure 1).

The unique side-chains of TSP impart valuable functionalities: it is a biocompatible, edible and biodegradable natural polymer,[4] characterised by broad pH tolerance, thermal stability, adhesivity, as well as high viscosity and non-Newtonian, pseudoplastic behaviour.[5] These characteristics make it ideal as emulsion stabilizer, thickener and binder in the food and pharmaceutical industries.[6]

Recently, TSP is gaining popularity also in cosmetics and particularly in skin care, for its ability to form films, hydrate, and create a protective barrier on the skin that reduces water loss. It has also been reported to improve skin elasticity, smoothness,[5] and the overall texture of personal care products, providing a silky, non-greasy sensation. Also the personal care industry, therefore, is starting to explore the potential of this versatile and upcycled hydrocolloid.

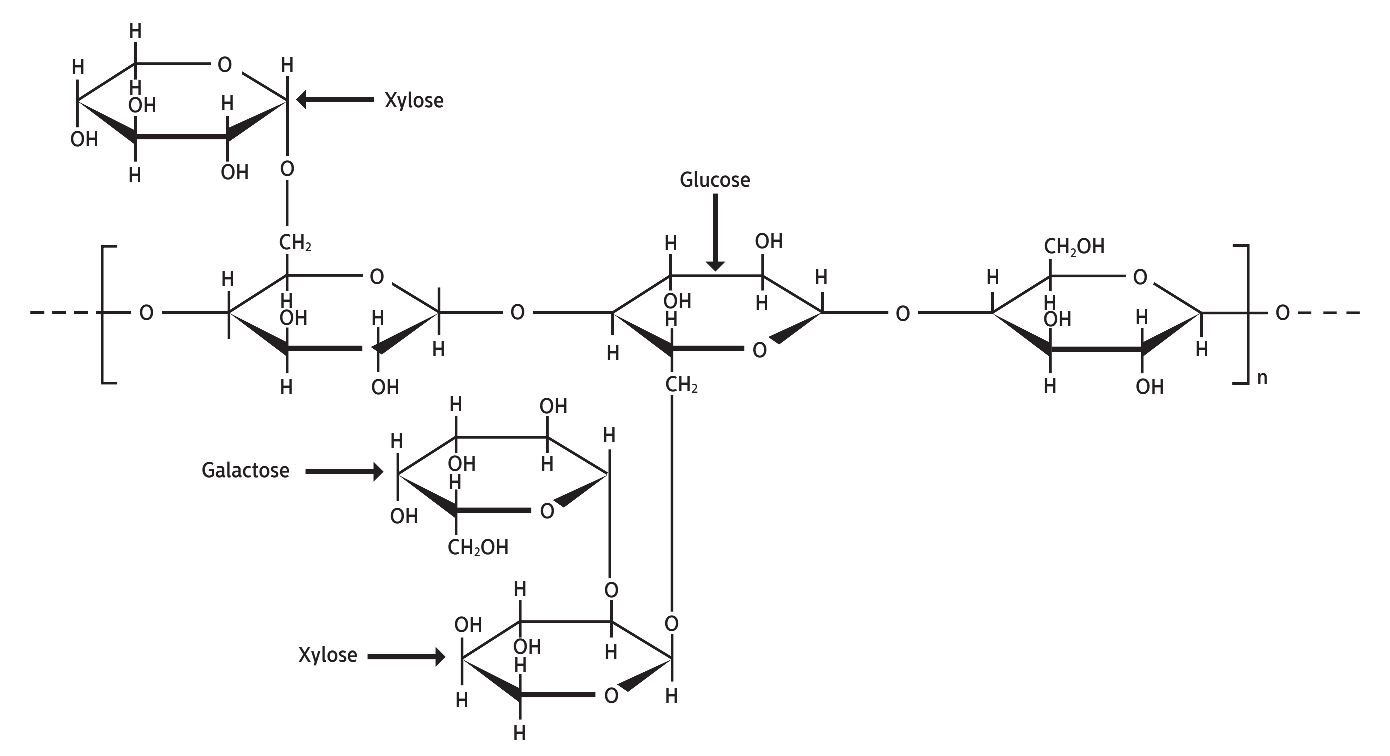

Figure 1: Structure of tamarind seed polysaccharide

The innovation: quaternized carboxymethyl tamarind (QCT)

Although possessing valuable technical properties and being non-carcinogenic, non-toxic, and non-irritating,[7] the limited solubility of tamarind gum in cold water typically restricts its application in personal care products.

Through a systematic research, Lamberti has investigated how chemical modifications could unlock the full potential of TSP in cosmetics. For instance, carboxymethylation of TSP can significantly improve its solubility, addressing a major drawback of this polymer.[8]

Furthermore, introducing a cationic moiety increases the conditioning properties of TSP, matching market standards, making it an ideal choice also for hair care applications. Hence, the resulting innovative QCT enhances both usability and performance, upcycling a byproduct into a high-performance beauty solution.

Notably, the polymer maintains its ready biodegradability (OECD 301F) and high Natural Origin Index (>0.85, ISO16128), distinguishing itself from market standards. This breakthrough underscores Lamberti's commitment to sustainable innovation.

Biodegradability

Biodegradability is a key measure of the environmental impact of chemical ingredients, referring to their ability to be biologically broken down into simpler compounds by living organisms. Options for readily biodegradable conditioners are currently scarce. The biodegradability of the novel QCT was assessed using the OECD 301 F method ('Manometric Respirometry method').[9]

Results confirmed the ready biodegradability of this new tamarind derivative, which achieves over 60% degradation within 28 days and meets the ten-day window requirement. In contrast, widely-used benchmarks like Polyquaternium-10 demonstrate low biodegradation levels (according to supplier data),[10] failing to meet the criteria for ready biodegradability.

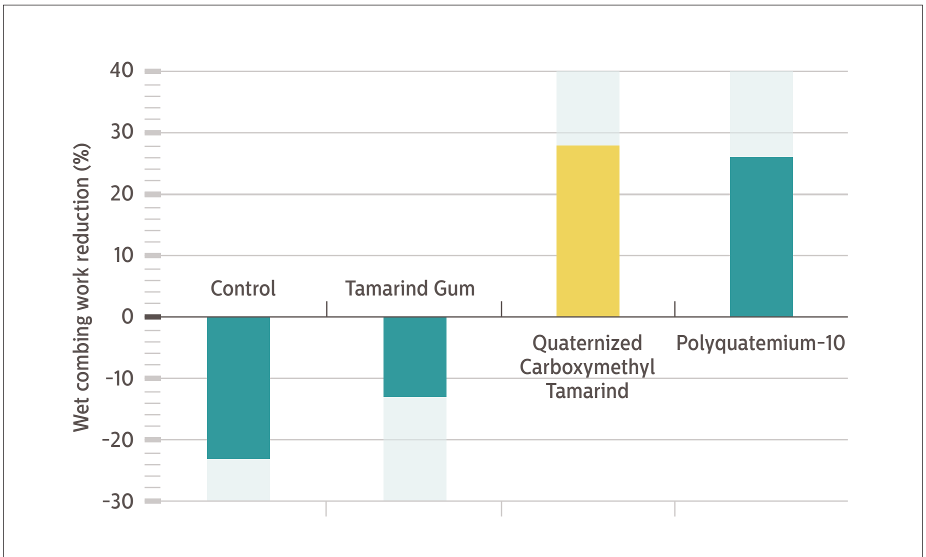

Figure 2: Comparison of wet combing performance

Hair care performance

While the sensoriality of the novel QCT makes it versatile enough to be used across various formulation types, including hair care and skin care products, this article will focus on its benefits as conditioning agent in rinse-off conditioners and shampoos.

To compete effectively with market standards, new natural or naturally-derived conditioning agents must demonstrate high performance, as the purchase of beauty products is driven by the desire for results, especially in hair care applications.[11] Immediate benefits such as effective hair adhesion for satisfactory combing, as well as enhancements in hair sensory and visual qualities, are therefore highly sought after.

Comparative studies between the new tamarind derivative, Polyquaternium-10, and control formulations without cationic polymers demonstrate the superior performance of QCT. This positions it as a valuable addition to environmentally responsible and high-performance personal care products.

Conditioning: wet combing

Instrumental evaluations demonstrated that the innovative tamarind derivative significantly reduces wet combing force, outperforming not only a control formulation without cationic polymers, but also tamarind gum. This underscores the critical role of chemical modifications to the native gum in enhancing the conditioning performance. Furthermore, QCT slightly outperforms Polyquaternium-10, revealing results in line with market standards (Figure 2).

For the combing test, a Diastron MTT175 Miniature Tensile Tester was used; this instrument measures the friction generated between a comb and hair fibres during grooming. All the polymers were tested at 0.5% inclusion level, in a conditioning shampoo chassis based on 10.1% SLES, 3.8% CAPB, pH 5.

Prior to combing force measurements, regular bleached Caucasian hair tresses were pre-washed with a 10% SLES solution,[12] for an effective elimination of potential contaminants from previous treatments. Then, the basic combing force of each individual tress was determined; tresses were then treated with the formulated shampoos and wet combing performance of each individual tress was evaluated and compared to the relevant basic value.

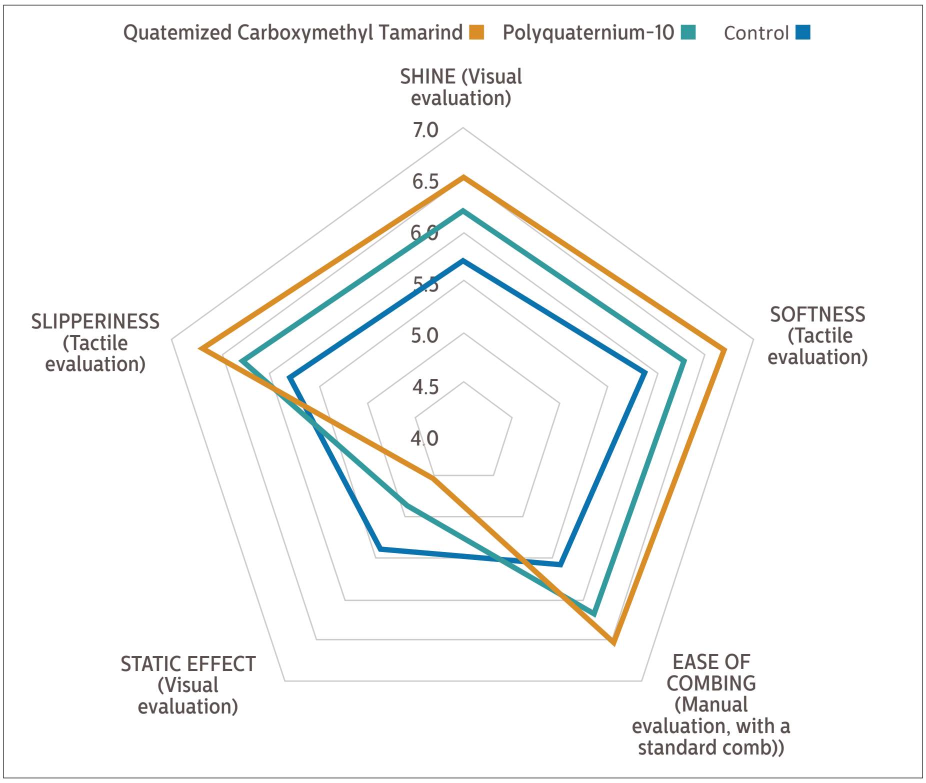

Figure 3: Sensory results on dry hair

Sensory benefits on dry hair

Aesthetics and sensoriality of dry hair are other critical parameters for conditioning agents. While consumers immediately notice how their hair feels when wet (a property associated with wet-combing results), effects on dry hair significantly affect overall satisfaction and perceived product efficacy.

Attributes such as smoothness, softness, shine, and manageability are essential for consumer acceptance and repeated product use. Assessing performance on dry hair provides therefore a complete understanding of the benefits conditioning agents offer.

Hair treated with QCT is softer, more slippery, easier to comb, shinier and with a reduced static/fly away effect compared to tresses treated with a control formulation (i.e. without polymers) and with Polyquaternium-10 (Figure 3). The novel tamarind derivative, therefore, surpassed established market benchmarks on dry hair.

The assessment on dry hair was performed by ten trained and expert panelists according to Quantitative Descriptive Analysis (QDA) standard protocol.[13] The test was carried out in a bioclimatic room (24 ± 2°C) on locks of straight, Caucasian, virgin hair (± 16 cm, ± 5 g), previously washed with a shampoo chassis based on 10.1% SLES, 3.8% CAPB, 0.5% polymer, pH 5.

Panelists evaluated and scored the hair tresses based on a blind, randomised order of presentation. The evaluation was repeated three times on three different days, with sample codes being changed at each working session. Higher scores indicate better performance in all categories except for static/fly-away effect, where lower scores correspond to superior results.

Foam quality

QCT also helps generating a softer and creamier foam (Figure 4A), when included into a surfactant-based formulation, compared to a control formulation without the polymer (Figure 4B).

This foam-enhancing property is particularly beneficial for hair and skin cleansing applications, as consumers highly value abundant, high-quality foam. Such foam is often perceived as an immediate indicator of superior care, contributing to an enhanced sensory experience and overall satisfaction with the product.

Formulation examples

To summarise, the properties and applicative benefits of QCT make this ingredient exceptionally well-suited for both hair and skin care applications. Its versatility allows it to be incorporated into a wide range of nature-inspired and eco-conscious formulations, including shampoos, conditioners, shower gels, skin cleansers, creams, and lotions.

Its ability to enhance conditioning, improve sensory attributes, and create a creamy, soft foam positions it as an ideal choice for high-performance products. Moreover, its sustainable and biodegradable nature aligns with the growing consumer demand for environmentally friendly ingredients. Table 1 and 2 depict two examples of hair care formulations containing QCT.

Conclusion

Esaflor T, Lamberti's novel quaternized carboxymethyl tamarind, represents a significant advancement in the field of conditioning polymers for personal care products. This innovative hydrocolloid, derived from Tamarindus Indica L., not only meets the high-performance standards required by the market but also addresses the growing demand for sustainable and biodegradable ingredients.

The novel QCT exhibits superior conditioning benefits, including enhanced detangling, shine, smoothness, softness, and anti-static effects, outperforming conventional Polyquaternium-10. Its sensorial and foam-enhancing properties further contribute to its desirability in hair and skin cleansing formulations, where high-quality foam is associated with premium care.

By upcycling a food industry byproduct and ensuring ready biodegradability, the QCT exceeds market sustainability expectations. This makes it a valuable addition to the portfolio of ingredients for formulators aiming to create environmentally responsible and high-performance hair- and skin-care products.

With Esaflor T, Lamberti demonstrated how thoughtful chemical modifications can enhance the performance of natural materials, achieving superior results while preserving their intrinsic natural essence. PC

Figure 4: Effect on foam of a rinse-off formulation (evaluation on a formulation based on 12.1% SLES, 4.2% CAPB, pH 5)

TABLE 1: NETTLE PURIFYING SHAMPOO

INCI Name	% w/w
Aqua (Water)	to 100
Sodium Coco-Sulfate (~100% a.m.)	6.9
Glycerin	3.0
Quaternized Carboxymethyl Tamarind	0.3
Lauryl Glucoside (Symbol 50% a.m.)	8.0
Disodium Coco-Glucoside Citrate (~30% a.m.)	10.0
Glycerin, Aqua (Water), Urtica Dioica (Nettle) Leaf Extract	0.5
Preservatives	q.s.
Parfum (Fragrance)	q.s.
CI 42090	q.s.
Citric Acid, 20% soln.	to pH~5

Properties: Appearance: slightly translucent viscous liquid; Viscosity (Brookfield RVT, 25°C, 20 rpm): ~ 4000 mPa.s; pH: ~ 5.0

TABLE 2: OAT BOUNCY CONDITIONER

INCI Name	% w/w
Aqua (Water)	to 100
Glycerin	2.0
C18-C22 Hydroxyalkyl Hydroxypropyl Guar	0.1
Quaternized Carboxymethyl Tamarind	0.5
Cetrimonium Chloride	1.0
Cetearyl Alcohol, Cetearyl Glucoside	5.0
Cocos Nucifera (Coconut) Oil	3.0
Amodimethicone, Cetrimonium Chloride, Trideceth-12	2.0
Preservatives	q.s.
Parfum (Fragrance)	q.s.
Glycerin, Aqua (Water), Avena Sativa (Oat) Kernel Extract	0.5
Citric Acid, 20% soln.	to pH~4.5

Properties: Appearance: glossy emulsion; Viscosity (Brookfield RVT + Helipath, 10 rpm, 25°C, 30''): ~ 20000 mPa.s; pH: ~ 4.5

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