

Bio-based guar gum derivatives to reach ambitious sustainability goals

MAURO RICCABONI

Lamberti SpA, Albizzate, Italy

Abstract

The main objective of this paper is to analyse all the steps that, from the seeds of an annual plant, lead to final cosmetic formulations addressed to customers interested in sustainability and water saving policies. This process goes through the manufacturing of a natural polymer, followed by its chemical modification, finally delivering environmental-friendly formulations.

We would like to discuss the whole process step-by-step, underlying how sustainability concerns could be taken into consideration in each single step, implementing a 360° approach to obtain a bio-based product, useful to support eco-conscious formulators into practice.

Keywords

- Sustainability
- Water saving
- People
- Bio-based product
- Cationic guar derivatives
- Guar crops
- Conditioning polymers
- Deposition-aid

INTRODUCTION

Sustainability is a business imperative and one of the most important mega trends of our times, not only a simple buzzword. People are every day more interested in naturally-derived products able to minimize the utilization of limited natural resources such as water but without affecting the final products' performances. In the chemistry sphere, sustainable development is addressed to reach global challenges such as fighting poverty and inequality, meanwhile respecting the environment.

In the cosmetic field, the journey to create a better and fairer world for everyone starts with the use of renewable raw materials, which goes ahead with green chemistry and it ends up in the hands of eco-conscious formulators.

Based on a polysaccharide derived from an annual crop, Lamberti patented a sustainable water-smart process (ESAFLORE ZERO-X technology) to obtain a cationic guar for personal care use. Besides the significant water savings, supplementary advantages of the new process are a higher yield, a relevant reduction of waste and energy consumption.

SUSTAINABILITY AND WATER

The events of 2020 accelerated consumer sustainability trends that had already been starting to emerge across many different markets. Despite being one of the most unpredictable years ever, it helped create greater public awareness about sustainability and deepen consumer understanding of the impact we are having on our planet.

The real question is: what is sustainability?

The most often quoted definition comes from the UN World Commission on Environment and Development: "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (1).

Sustainable practices support ecological, human, and economic health and vitality. This perspective presumes that resources are finite, and should be used conservatively and wisely with a view to long-term priorities and consequences of the ways in which resources are used. In simplest terms,

sustainability is about our children and our grandchildren, and the world we will leave them.

Water is at the core of eco-conscious development and is critical for socio-economic development, energy and food production, healthy ecosystems and for human survival itself.

Even though there is nothing more essential to life on Earth than water, people are struggling to access the quantity and quality of water they need for drinking and cooking.

During the last few decades, it has become evident that a steadily increasing demand of water, leading to a water crisis, that is a situation where the available potable, unpolluted water within a region is insufficient to meet that region's demand (Figure 1). Today, 1.42 billion people – including 450 million children – live in areas of high or extremely high water vulnerability (2). The reduction of water scarcity is a global goal. The World Economic Forum lists water crisis as the largest global risk in terms of potential impact (3).

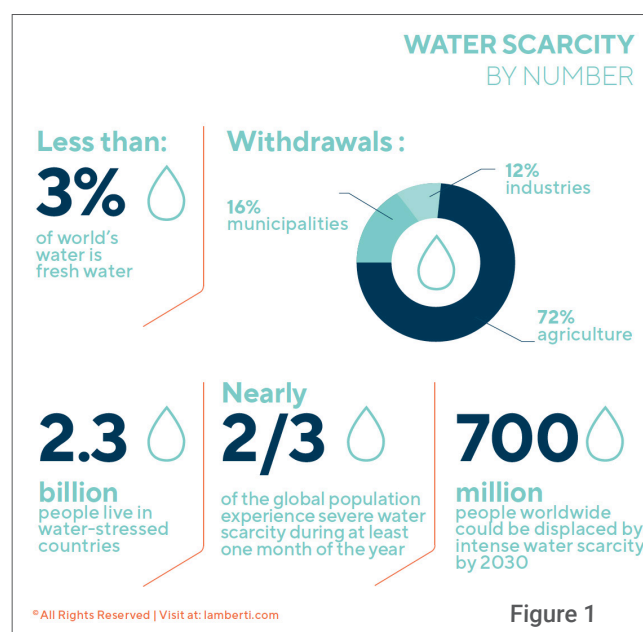


Figure 1

At the current usage rate, this situation will only get worse: 700 million people worldwide could be displaced by intense water scarcity by 2030, and ecosystems around the world will suffer even more (2).

While agriculture is the main culprit for water dearth, the boom in the personal care industry is a growing contributor. On the other hand, the more consumers are becoming aware of the cosmetic impact, the more pressure is being placed on beauty brands to create sustainable solutions.

Already, leading beauty companies are taking up the challenge and all the top brands worldwide are reducing the water content of their products, driven both by eco-friendly concerns and by consumer demand for more concentrated and effective products.

Mintel's key beauty trends for 2025 included water as "the new luxury," suggesting brands need to limit dependence on it (4). The study notes that 61% US consumers would rather companies worked to improve their business practices to be green than make donations to green organization and 34% Italian consumers are interested in double concentrated shower products. According to this survey, water conservation is not yet considered an issue in Asia-Pacific, here the issue is more about access to clean and no-polluted water rather than water shortage.

Mintel underlines consumer awareness is on the rise and predicts water saving will be a key trends for personal care industries in the next years.

THE GUAR CROP

ESAFLORE ZERO-X technology starts from guar plant, an annual legume that flourishes in extremely arid and drought-affected regions where most plants perish.

Guar plant (*Cyamopsis Tetragonoloba*) can grow receiving low rainfall, without any additional irrigation. It requires very little water during its growing season and its taproots can access soil moisture in low soil depths (5).

In addition, guar grows in poor soil with low input cost and without requiring extensive use of fertilizers and pesticides.

Guar plant improves nitrogen availability in soils and the ploughed crop residues have been shown to increase significantly the yields of succeeding crops. A relatively short growing season makes guar a viable rotation crop (5).

THE GUAR SOCIAL SUSTAINABILITY

India is the largest producer of Guar and contributes to over 80% of total guar production in the world. The crop is produced mostly in rural and under-invested regions of Rajasthan, Haryana and Gujarat, in the north part of India (5).

Guar is a sustainable crop not only for its specific qualities but also for the people involved in its supply chain (6).

The majority of the guar produced in India is exported, mainly to the USA, but also to China and European countries.

Guar crop has experienced a remarkable journey from a traditional crop grown on marginal lands mainly for food and animal feed to a crop with huge market interest. Yet, the starting point of this valuable supply chain remains the Indian local farmers working in a poor area of India. Besides them, the guar business entails different actors, everyone playing a pivotal role in granting and preserving this important pulse crop of India.

Social sustainability could be an often-overlooked aspect of sustainability: equal opportunity, freedom and self-awareness make people positive promoters of change.

THE GUAR GUM

Guar is a pod-bearing plant with six to nine seeds per pod. The guar seeds are the source of the natural polymer called guar gum (7).

The seed consists of three parts: the hull, the endosperm and the germ. It is from the endosperm, that guar gum is derived, which is the prime marketable product of the plant.

The gum is extracted from seeds essentially by a mechanical process of roasting, differential attrition, sieving and polishing (Figure 2). The seeds are broken and the germ is separated from the endosperm. Two halves of the endosperm are obtained from each seed and are known as undehusked guar split. When the fine layer of fibrous material, which forms the husk, is removed and separated from the endosperm halves by polishing, refined guar splits are obtained. The hull (husk) and germ portion of guar seed are termed as guar meal which is a major by-product of guar gum powder processing and is utilized as cattle feed. The refined guar splits are then treated and finished into powders (known as guar gum) by a variety of routes and processing techniques depending upon the end product desired. The guar splits are crushed in flaker mill and then uniformly moved to grinder. The grinded material is dried and passed through screens for grading of the material according to the particle size. Various grades are available depending upon purity, color, mesh size and viscosity potential (7).

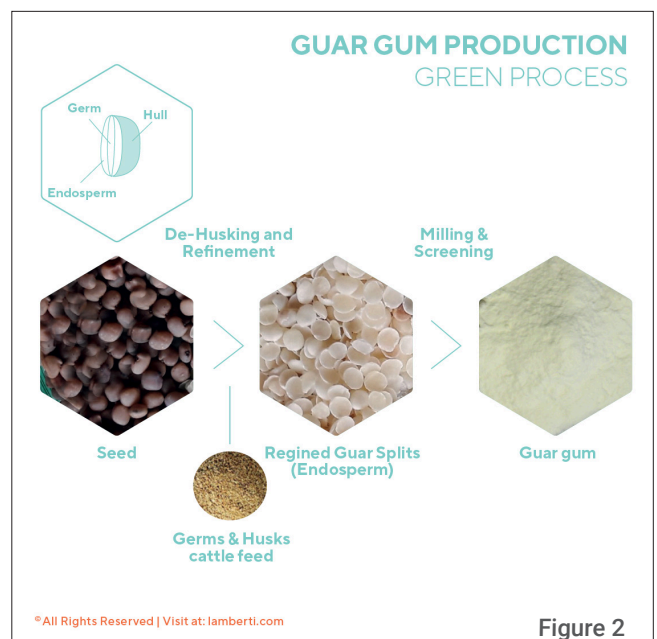
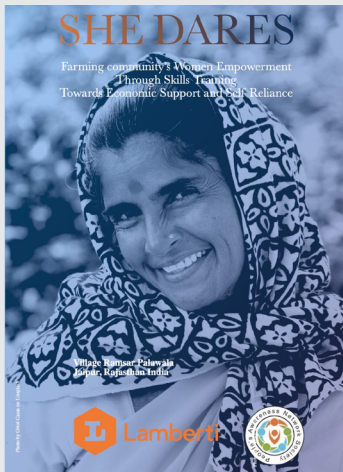


Figure 2



SHE DARES

Lamberti India in collaboration with the NPO "People's Awareness Network Society" (PANS), is championing "She Dares" project for the empowerment of women in Rajasthan by increasing their abilities and competencies. One of the important cash crop of this area is guar. COVID19 lockdown

has augmented gross poverty and unemployment levels among the men and women. The project is focusing on those women who are socially and economically disadvantaged.

The project targets 50 young women within the communities of Ramsar Palawala, Jaipur, Rajasthan, giving priority to the most vulnerable who are completely illiterate.

The duration of the project is one year and will include ten months of formal education and three months of vocational training and post-training support for setting up a village business.

Women's education will change future generations.

This whole process does not entail chemicals and does not generate any waste or wastewater.

Chemically speaking, guar gum is composed by a polysaccharides that belongs to the family of galactomannans, which are linear polymers of β -(1,4)-linked D-mannose that are substituted with α -(1,6)-linked D-galactose monomeric branches (8).

This natural polymer is the backbone of cationic guar derivatives.

THE CATIONIC GUAR

Guar gum can be chemically modified into various derivatives by substituting the reactive hydrogen from free hydroxyl groups along the macromolecular backbone with different reactive functional groups. This modification improves its solubility, performances and its overall characteristics broadening its outlook in numerous applications. One of the most widely used cationic polymers in the personal care industry is cationic guar, which is produced by an etherification reaction on guar gum, followed by purification with water (8).

Companies' ability to reduce industrial water consumption plays a pivotal role to mitigate the impending shortages. ESAFLOR ZERO-X technology represents a sustainable and water-saving process to obtain cationic guar since it allows to remove the final purification step (9).

This environmental-friendly process, with respect to the consolidated process, permits to obtain a cationic guar with

similar chemico-physical characteristics and application results but saving water, avoiding the corresponding need of waste water treatment.

Moreover, the simplification of the manufacturing procedure is translated into a reduction of energy and industrial utilities. The use of ESAFLOR ZERO-X ingredients does not affect the labelling of the final product, the INCI name remains the same (Guar Hydroxypropyltrimonium Chloride or Hydroxypropyl Guar Hydroxypropyltrimonium Chloride) and moreover the pure cationic form is conform to Cosmos standard.

THE FINAL APPLICATION

Cationic water-soluble derivatives of natural guar gum provide dual benefits of conditioning and thickening (10, 11). Thanks to their cationic character, these products interact with keratin providing a conditioning effect on hair and skin, reducing the negative effects of soaps and surfactants. Not only they are compatible with most anionic and amphoteric surfactants, but they also work as foam boosters when in combination with them. Due to the high molecular weight of the polysaccharide backbone, these products create viscosity both in aqueous and surfactant based solution. Cationic guar (INCI Guar Hydroxypropyltrimonium Chloride and Hydroxypropyl Guar Hydroxypropyltrimonium Chloride) are particularly efficient at forming polysaccharide-surfactant coacervates, enhancing the deposition of insoluble actives (10, 11). Depending on the grade, these plant-derived polymers can be applied for transparent or opaque formulations, conveying the following benefits:

- Conditioning effects on hair & skin
- Superior hair combability & improved hair feel
- Enhanced deposition of water insoluble actives
- Foam booster
- Thickening aqueous & surfactant based solutions
- Natural origin, eco-friendly and sustainable

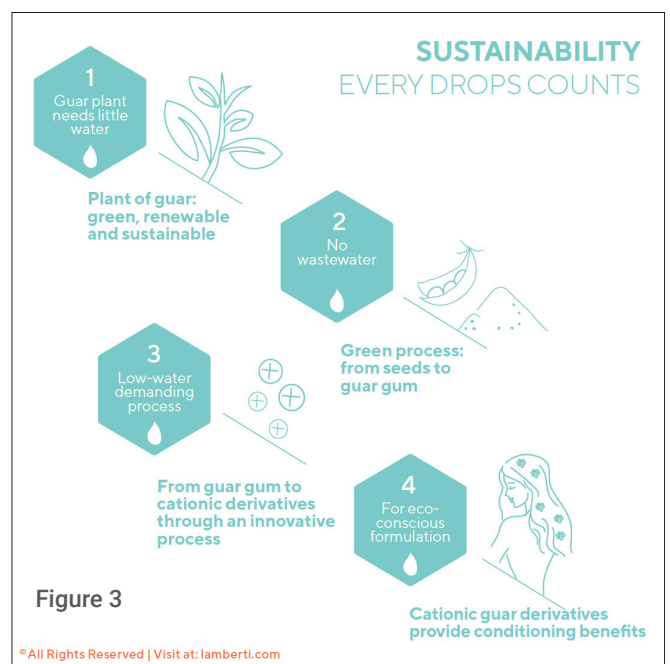


Figure 3

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THE TAKEAWAY

Summarizing, every water drops counts in ESAFLOR ZERO-X technology (Figure 3):

1. The starting point is a plant, a renewable and sustainable source that is also an important crop for Indian people. The guar plant just needs little water.
2. The seeds of this plant are transformed in a natural polymer by means of a green and smart process that does not waste any water.
3. The natural guar gum is chemically modified into cationic derivatives through an innovative and low-water demanding process.
4. The resulting cationic guar derivatives are suitable for cosmetic applications.
5. These ingredients are addressed to eco-conscious formulators and Cosmetics & Personal Care companies committed in saving water.

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ABOUT THE AUTHOR

Mauro Riccaboni graduated in Organic Chemistry in 2000. He worked in Medicinal Chemistry R&D until 2012, when he joined Lamberti Group. After working six years as R&D hydrocolloids derivatives laboratory head, Mauro has been appointed Sales & Hydrocolloids Product Manager for Personal Care. With a strong chemistry background, Mauro is a bridge between market needs and R&D activities.

SHORT ADVERTORIAL



ZURKO RESEARCH EXPANDS ITS SERVICE PORTFOLIO BECOMING A SHAREHOLDER OF CTC, A SPANISH CRO SPECIALIZED IN HAIR CARE

Zurko Research incorporates a new area dedicated to hair care to its service offering, acquiring part of the shares of Capillary Technology Center (CTC), a CRO located in Barcelona with more than 25 years of experience in haircare studies.

Throughout its years in business, CTC has positioned itself as a leading capillary testing laboratory, developing profound knowledge in all types of studies related to hair and skin appendage evaluation. All the extensive experience CTC has gained along this journey allows them to substantiate a wide range of claims applicable to this area. In addition to its experience in efficacy testing, CTC also has a significant track record in the field of training and tailor-made project advice.

Capillary Technology Center, from now on Zurko-CTC, will continue to develop its clinical evaluation activity in Barcelona with its team of experts, under the management of **Zurko Research**,

"We are very happy with the incorporation of this new haircare area in our business as it allows us to further enrich and gain new knowledge of personal care, which is complementary to the services that Zurko is already offering to its clients", comments Sabina Giovannini, CEO of **Zurko Research**.

Eni Gómez, from CTC, adds that "the entry of **Zurko Research** will provide an enriching vision to further expand the experience acquired in the haircare area and it will allow us to face future challenges with a larger, multidisciplinary team".

The collaboration will offer new opportunities to continue with the mission of both teams to respond in a professional and increasingly complete way to the needs and expectations of their current and future clients.

CONTACTS:

www.zurkoresearch.com - info@zurkoresearch.com