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Allured business media

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ties that bind

One of the top trending articles on *CosmeticsandToiletries.com* relates to skin binding and ingredient delivery.* In it, nano-sized, spherically arranged nucleic acids are described that bind to natural proteins and penetrate the skin to deliver a payload. For example, an ointment containing nanostructures targeting the epidermal growth factor receptor was found to penetrate the skin, with cells taking up 100% of the nanostructures and selectively decreasing levels of the problem proteins.

Binding is not a new phenomenon, but interest in it continues for improved ingredient delivery and efficacy. Clearly, actives such as the natural dipeptide described by Mondon et al. on Page 658 and the ingredients for evening skin tone reviewed by Teran on Page 644 would be ineffective if they could not reach their target sites. Illustrating the effects of binding is the article by Klock and Rosenberger on Page 636, which describes saccharide isomerate, designed to bind to skin and provide lasting hydration and soothing benefits from both leave-on and rinse-off products.

In Memory

In life, another aspect of binding relates to family and friends and the memories we make. On a sad note, "Bud" (Franklin) Brewster, former technical editor for *Cosmetics & Toiletries*, passed away on July 29, 2012. Past authors and advisors will recall his sharp eye for detail, friendly demeanor and enthusiasm for life, and readers may remember his witty "Bench & Beyond" columns. He had an endearingly inquisitive mind, which served him very well as technical editor for us and beyond. He was a wonderful mentor and friend, and taught me to see not just what is on a page but what isn't. Everything that *Cosmetics & Toiletries* is today was shaped in some way by him. He will be missed.

** www.cosmeticsandtoiletries.com/research/techtransfer/161439005.html*

Saccharide Isomerate to Deeply Hydrate Skin and Scalp

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KEY WORDS: *saccharide isomerate, deep hydration, moisture retention, rinse-off*

ABSTRACT: *Saccharide isomerate, designed to closely resemble a carbohydrate complex found in human stratum corneum, is shown here to provide up to 72 hr of deep hydration to skin and, for the first time, rinse-off soothing to the scalp. Its unique binding mechanism to skin and scalp create new opportunities for leave-on and rinse-off products.*

Consumer interest in premium beauty products continues unabated, with a focus on scientific innovations accompanied by the desire for natural ingredients and green product lines. Trend research confirms that a strong group of buyers places particular value on high quality products with unique features; such products contribute to a sense of well-being and allow users to express their individuality through their appearance. However, a pleasing appearance and the self-confidence it inspires depend to a great extent on the health and integrity of the skin—and millions of people all over the world suffer from excessively dry skin.[1]

In addition to considerable physical discomfort, rough, flaky or irritated and dry skin can cause psychological distress and embarrassment in social situations. Hydrating the skin therefore remains an important function of personal care products. In particular, 70% of women believe they have a sensitive scalp and seek products that give tangible relief from this condition.[2] The scalp may feel taut and itch uncomfortably, a sign that it is in need of deep and sustained hydration.

Until now, a significant formulating challenge has been maintaining hydration levels in the skin and scalp because rinse-off products can leach the natural moisture from the skin and wash away traditional moisturizers such as glycerin and urea. Consumers look to skin and hair care products to provide protection against dry skin and itchy scalp. Moreover, there is a growing tendency among

Table 1. Compositions of saccharide isomerate compared with natural SC carbohydrate complex

Compound	Carbohydrate fraction of SC (%)	Saccharide isomerate (%)
Psicose	0.2	0.5
Glutose	2.2	0.2
Mannose	3.0	3.6
Fructose	31.1	37.0
Glucose	46.7	53.3
Galactose	2.1	1.3
Various	14.7	4.1

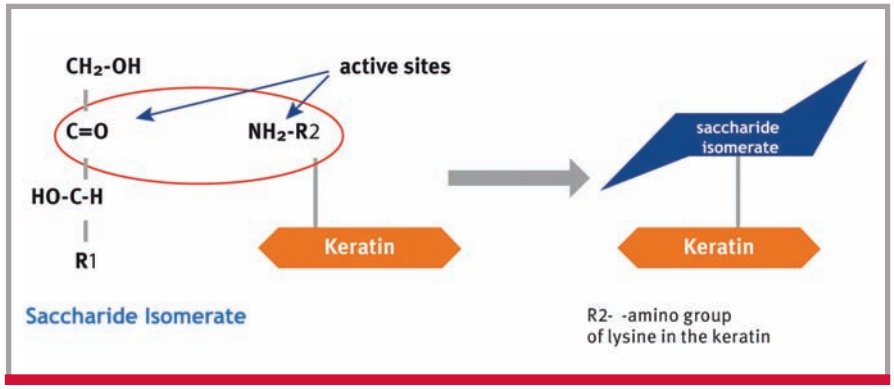

Figure 1. Saccharide isomerate mechanism of action

consumers to expect cosmetic products to also integrate soothing and hydrating functions, making them more efficient and giving added value.

Considering these expectations and formulating challenges, the comprehensive research and development of saccharide isomerate has shown promise for meeting the consumer need for deep, lasting hydration and a comfortable skin feeling. Tests indicating such, including those for moisture retention, skin hydration and skin barrier strengthening, are described here.

Saccharide Isomerate

Saccharide isomerate is derived from the D-glucose of wheat and is similar in composition to the endogenous carbohydrate complex in the natural moisturizing factor (NMF) found in the stratum corneum (SC) (see **Table 1**); however, it binds to the ε-amino group of lysine in the keratin of corneocytes (**Figure 1** on Page 638).[3] This unique binding mechanism ensures that the active is not washed away but continues to improve hydration until removed by the natural process of desquamation. Hence, saccharide isomerate supports SC hydration and water retention in the short term, leading consequently to improved desquamation in the mid to long term.

DNA microarray assays on human keratinocytes have shown that saccharide isomerate effectively stimulates genes that play a key role in skin barrier improvement (see **Figure 2** on Page 640). Specifically, the upregulation of the genes for filaggrin and hyaluronan synthase-3 indicates improved skin hydration ability by boosting NMF and hyaluronan levels. Also, increases in loricrin and acid sphingomyelinase gene expression strengthen the cornified envelope and stimulate ceramide synthesis, respectively.

Mechanisms of Skin Dryness

To understand the activity of saccharide isomerate, it is first helpful to review the mechanisms underlying skin dryness. Dry, itchy skin is a warning from the body that the protective elements of the epidermis are not coping with the demands made on them. Although age remains an important factor in dry skin, environmental factors play an ever greater role. Central heating, air conditioning, traveling by plane and harsh weather conditions all have detrimental effects as they expose skin to extreme and rapid changes in humidity. Such rapid changes represent a severe challenge to the biosensor function of the skin. Frequent exposure to detergents and chemicals further reduce the ability of the skin to maintain its natural barrier, causing it to become dehydrated. In healthy skin, water loss is regulated by the outermost layer of the epidermis, the SC. Hydration proceeds from the inside out and underlying layers of the skin supply sufficient moisture to the SC. Even in healthy skin, some water must be expended to hydrate the outermost layers of the SC to maintain their flexibility and facilitate the enzymatic reactions that drive their maturation. Dry skin occurs when the rate of desiccation is faster than the rate of resupply or retention of water from the epidermis. The SC is complex in nature. It is a selectively permeable, heterogeneous, composite layer of the epidermis designed specifically to provide a barrier to the outside world, preventing water loss and protecting the organism against environmental challenges.[4]

The SC uses three main mechanisms to retain water. First are the cells of the SC, the corneocytes, which regulate water flux and retention. They are bound by corneodesmosomes and surrounded by a hydrophobic cornified lipid envelope, both of which help to lengthen the diffusion path of water in the SC. Next are the intercellular lamellar lipids, predominantly arranged as an orthorhombic, laterally packed gel, which provide a tight and semi-permeable barrier to the passage of water through the tissue. Finally, the hygroscopic molecules of the NMF are present both inside and between the cells. They absorb and retain endogeneous but also exogeneous water, making them efficient humectants.[5] Healthy skin is rich in NMF, which is found only in the upper layer of the SC. However, because NMF is composed of a blend of water-soluble components, it is easily leached through water contact, i.e., washing, showering and bathing, which is why repeated contact with water actually makes the skin drier.

Retaining Moisture

In relation, the dynamic bioengineering Moisture Accumulation Test (MAT) can be used to provide information about the moisture retention

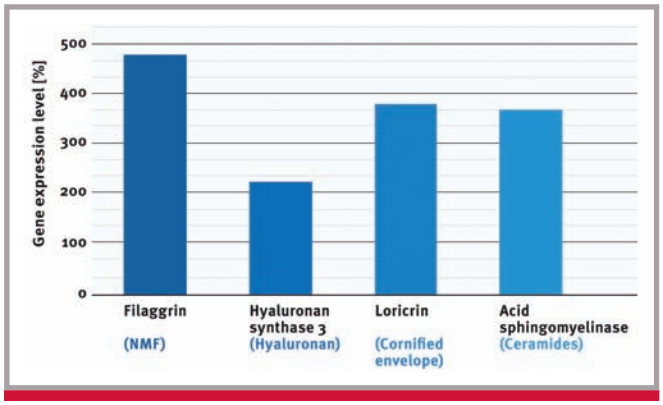

Figure 2. Induction of gene expression in human keratinocytes by 0.3% saccharide isomerate

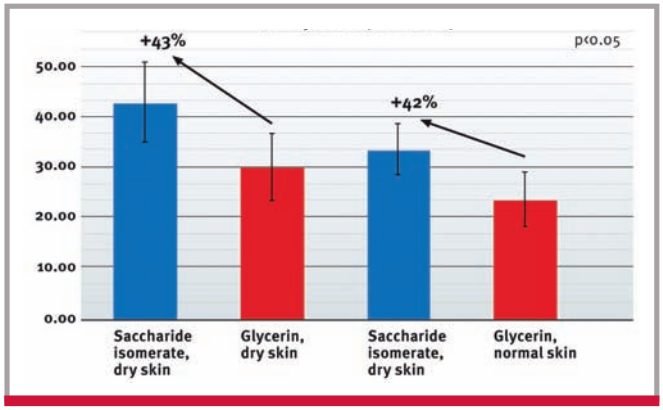

Figure 4. Skin hydration % increase

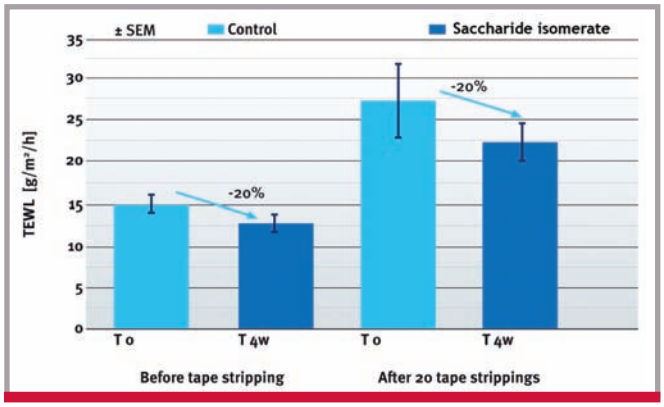

Figure 5. Change in TEWL as an indication of skin barrier strength

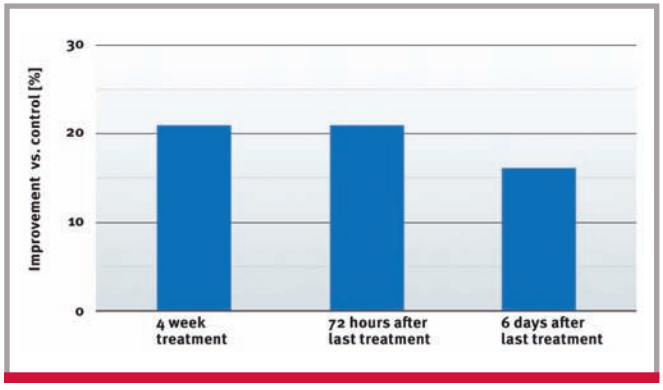

Figure 6. Improvement in signs of dry skin according to Kligman's grading system

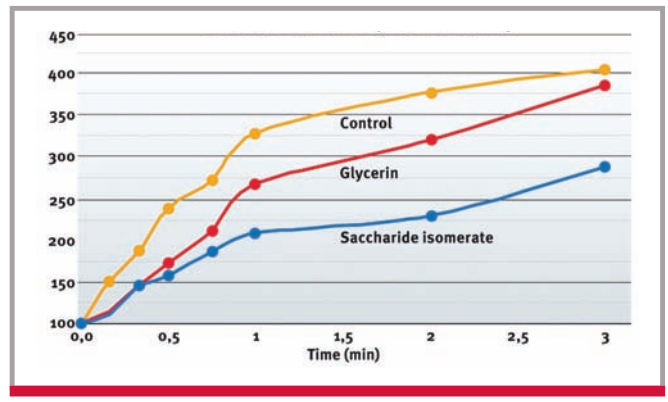

Figure 3. Moisture accumulation in NOVA meter units

capacity of skin by measuring the accumulation of moisture on its surface.[6] Specifically, a meter[a] is left in contact with skin and used to obtain impedance based capacitance readings at the beginning and end of a treatment period. The use of this occlusive treatment results in unbound water diffusing through the skin to accumulate on the skin surface. A flatter moisture accumulation curve therefore means greater moisture-retaining capacity.

As indicated under Voegeli et al. in more detail,[7] approximately 3 mg/cm^2 of two o/w test formulations containing 5% of either saccharide isomerate or glycerin were applied by six female test subjects, ages 35–55, having dry skin. Formulas were applied twice daily to opposite sides of the volar forearms during a 14-day treatment phase and the results compared.[7] For the MAT, 12 hours after the last test application, the meter was left in contact with the skin of the volar forearm for 3 min.

The saccharide isomerate formulation instantly retained more moisture in the skin than glycerin. It also increased the skin's moisture retention capacity by 38%, compared with the control area (see **Figure 3**). Glycerin increased skin's moisture retention capacity by 6%, which was similar to the value of the control area. Under the same test conditions on both dry and normal skin, 5% saccharide isomerate outperformed 5% glycerin by nearly 50% (see **Figure 4**).

> Hydration proceeds from the inside out and underlying layers of the skin supply sufficient moisture to the SC.

Hydration Delivery, Barrier Strengthening

An in vivo efficacy study also was used to substantiate the ability of saccharide isomerate to strengthen the skin barrier function and deliver hydration. Twelve female subjects, ages 40 ± 1, participated in the study. Areas of skin on their calves were evaluated after a two week wash-out phase, during which only a standardized shower gel was used, followed by a four-week treatment of a 1% aqueous saccharide isomerate solution[b] applied twice daily, and compared with untreated skin. Before, and three

[a] *The NOVA DPM 9003 is manufactured by NOVA Technology Corp., Porthsmouth, NH USA.*

and six days after the treatment phase, skin was measured and evaluated by clinical grading according to Kligman.[8] Barrier disruption was induced by tape stripping after four weeks of treatment and barrier repair assessed by transepidermal water loss (TEWL). The area was photographed before and after treatment, and after both two and four weeks of treatment, subjects were asked to fill in a questionnaire rating their experience of the product. A six-day regression phase followed the treatment phase during which no saccharide isomerate solution was applied; only a standard shower gel was used.

The 1% solution was found to strengthen skin barrier function, as shown by a 20% reduction in TEWL before and after 20 subsequent tape-strippings following a 28-day application (see **Figure 5**). According to Kligman's grading, the 1% solution reduced dry skin signs by 20% after four weeks. After the final treatment, the effects of the saccharide isomerate solution lasted for 72 hr, likely due to a buildup in the skin (see **Figure 6**).

Photographs demonstrated a significant improvement in skin's appearance after four weeks of application with the 1% saccharide isomerate solution. In addition, SC desquamation clearly was normalized (see **Figure 7**). Consumer panel testing (see **Figure 8**) showed that after two weeks, the 1% saccharide isomerate solution improved skin softness, smoothness, flaking and itching each by 50%, and skin tightening by more than 30%. In addition, it improved skin robustness by more than 20%.

[b] *Pentavitin (INCI: Saccharide Isomerate) is a product of DSM.*

Saccharide isomerate supports SC hydration and water retention in the short term, leading to improved desquamation in the mid to long term.

Effects in Rinse-off Products

An additional study under rinse-off conditions demonstrated the saccharide isomerate solution to provide protective effects for sensitive and itchy scalps. The product was analyzed for barrier repair by TEWL and for irritation intensity by colorimetric measurements. The study was performed by an independent institution and involved 18 subjects. A 0.2% saccharide isomerate solution was compared to an untreated area and benchmarked with 0.03% bisabolol solubilized in 0.03% PEG-40 hydrogenated castor oil. Both were dissolved in water.

Application was standardized, with 2 µL/cm² of the products applied to pre-defined forearm areas. The area was then humidified using a water atomizer to mimic showering—one spray every 10 sec. Products were massaged into the skin by hand for 3 min using a fingerstall and soft circular massaging movements to simulate washing with shampoo. The area was then given a standardized rinsing for 1 min using three water-soaked cotton pads. Finally the area was dried by tapping with a paper tissue and constant pressure—three passages, standardized.

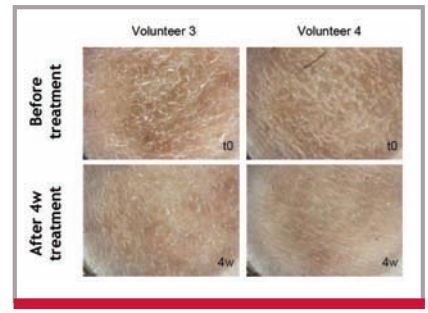

Figure 7. Skin appearance photographs

The ingredient solutions were applied to the forearm under rinse-off conditioning, as described, and skin irritation and barrier disruption were induced by tape stripping. Barrier repair was assessed on the basis of TEWL[c] and irritation by skin colorimetric measurements[d]; *a* value:

Because NMF includes water-soluble components, it is easily leached through water contact, i.e. bathing, making the skin drier.

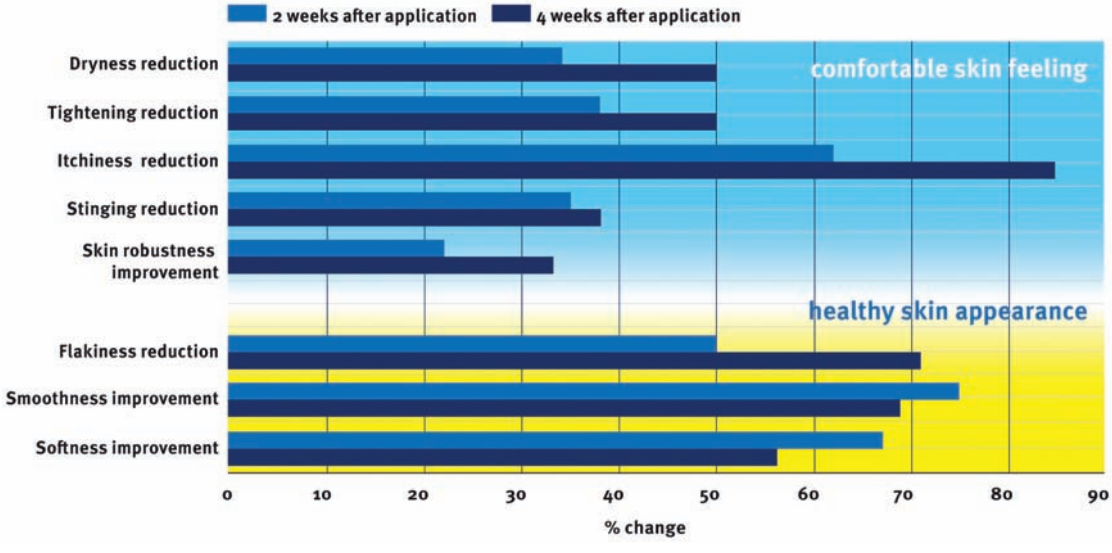

Figure 8. Improvement in skin feel and healthy appearance

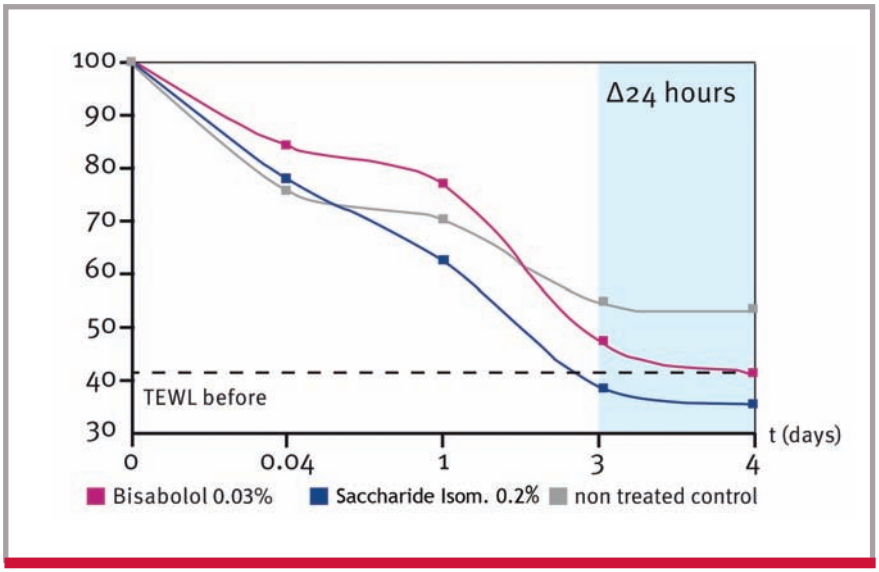

Figure 9. Reduction in TEWL (%)

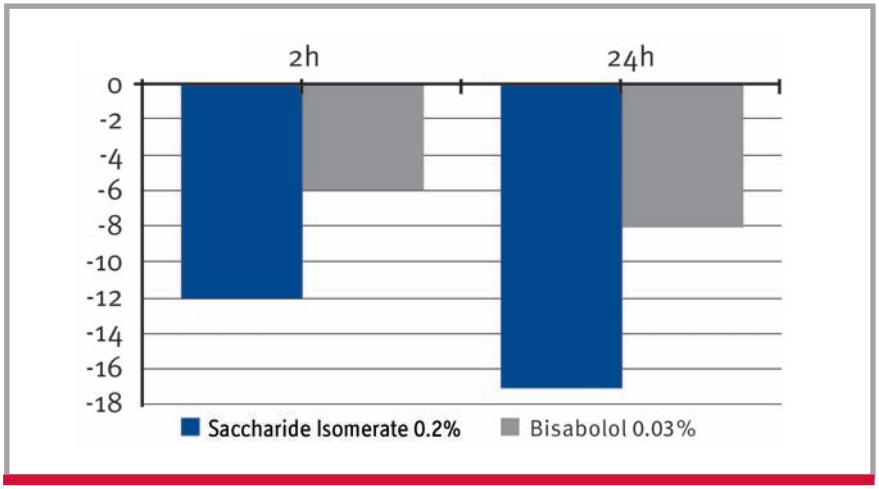

Figure 10. Reduction in irritation (%)

green-to-red spectrum. Measurements were taken after 2 hr and 1, 3 and 4 days, and a statistical analysis was performed.

Full skin repair was defined by TEWL levels before tape-stripping. During pre-treatment, the TEWL levels were constant and tape stripping induced an increase of about twofold. The 0.2% saccharide isomerate solution was found to repair the scalp barrier after three days with a significance of $p < 0.05$, whereas bisabolol took four days to reach the same repair level without being significant. In other words, saccharide isomerate was 2.3 times faster than the untreated area and as much as 24 hr faster than the leading benchmark (see **Figure 9**). The reduction in irritation as measured by itch was, for the 0.2% saccharide isomerate solution, 12% after 2 hr and 17% after 24 hr, whereas bisabolol showed a reduction of 5% after 2 hr and 8% after 24 hr. Overall, saccharide isomerate reduced the irritation by twice that of the benchmark, bisabolol (see **Figure 10**).

Conclusion

The ingredient reviewed here was found to address the widespread and growing consumer need for short- to long-term skin hydration, providing the extra care and support required by dry skin and sensitive scalp, especially when exposed to adverse environmental influences, detergents and household products. Gene expression studies have demonstrated that saccharide isomerate stimulates key genes to improve skin barrier function, and a variety of in vivo studies confirm its ability to strengthen the skin barrier and maintain deep hydration for 72 hr. This imparts a soothing action that, due to its unique binding mechanism, is not lost with rinse-off care products.

The affinity of saccharide isomerate to skin is based on its composition, which is very similar to that of the endogenous carbohydrate complex, contributing significantly to skin and scalp hydration. Further, trend research results show that green and natural ingredients are increasingly important factors in the consumer's choice of product, and since it is derived from the D-glucose of wheat, saccharide isomerate fully meets the criteria for plant-based natural products.

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[c] *The Tewameter TM 300, and*
[d] *The Colorimeter CL400 are manufactured by Courage and Khazaka Electronic GmbH, Germany.*

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