

Technological-sensorial sphere for sustainable cosmetics

Eco-designed microplastics alternative



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Abstract

This work aims at presenting the evidence towards sustainable cosmetics, in which performing and eco-designed ingredients are necessary. The ingredient represents one of the latest results in R&D towards innovation in texturizers. With proved performances against standard plasticizing powders and peculiar environmental-friendly impact on the Environment (readily biodegradable according to OECD 301 method), it represents an efficient and valid alternative to formulate sustainable cosmetics, by maintaining or improving, all the technical cosmetic performances but replacing standard powders like Nylon, PMMA, Polyurethane and PE. A series of tests have been performed to evaluate the ingredient's performances in personal care formulations.

Keywords:

- Texturizers
- Microplastics
- Sustainability
- Leave-on
- Biodegradability
- Eco-designed
- Peer Reviewed

INTRODUCTION

Every day, tonnes of plastic "dust" from personal care products, for example microbeads with an exfoliating function for shower gels and various "rinse-off" cleansing products, are poured into seas, together with microplastics having specific technical properties used in face and body creams, sunscreens and make-up, non-rinsing, or "leave-on" products. Common microplastics are not biodegradable and once in the environment, they could accumulate in animals, including fish and shellfish and consequently end up in our food chain. An analysis carried out by Amec Foster Wheeler shows that around 2000 Tons of microplastics every year goes from cosmetics to the sea.

Prompted by concerns for the environment and human health several countries have already started to ban the use of microplastics into rinse-off products as South Korea, USA, EU (Sweden, France, Italy and many others). In order to have a common legislation in all Europe, and to really understand the impact of a restriction of microplastics production and use, ECHA has been commissioned by the European Commission for a safety and impact evaluation of microplastics which are intentionally added to finish products (not only cosmetics, but also other market segments). ECHA proposal is today following the iter to become an effective ban, it is expected to be in its final version by 2021, regulating both rinse-off and leave-on cosmetics.

Cosmetic industry is therefore moving towards the use of natural or biodegradable ingredients that can replace standard microplastics such as Nylon-12, PMMA (Polymethylmethacrylate), Polyurethanes etc.

With the intention of preserving and regenerating natural resources through innovative development, giving to the market a valuable alternative to microplastics, Celus-Bi® Feel is the result of a strategic partnership between ROELMI HPC and NOVAMONT, a market leader in the biopolymers field. A specific transfer of technology to cosmetic market,

with a number of innovative steps allowing a new patent, leads to a synergistically combination of natural derived *Zea Mays Starch*, *Glycerin* from olive oil non-edible fractions and biodegradable *Polyvinyl Alcohol*: a sensorial powder able to maintain the high level performances of microplastics, while being readily biodegradable in the same time.

MATERIALS AND METHODS

Celus-Bi Feel (INCI: *Zea Mays Starch*, *Polyvinyl Alcohol*, *Glycerin*) is a fine powder with a characteristic odour and colour from white to cream, which is available in different granulometries: 5 µm 10 µm and 20 µm.

Safety tests, oil affinity capacity and clinical tests took place at Complife Italia Srl, an independent testing laboratory for safety and efficacy assessment of cosmetics, food supplements and medical devices. Aqueous aerobic biodegradation test based on CO₂ evolution Biodegradability performances have been tested by OWS (Organic Waste Systems), a world leading company in the construction and operation of anaerobic digestion plants, in the biodegradability and compostability testing of different types of materials, and in waste management consultancy.

Assessment of safety parameters

Safety tests have been performed according to the legislation in force. *In vitro* MTT assay for the evaluation of the cytotoxic potential. *In vitro* Het Cam Test for the eye irritating potential cytotoxic potential (5 % in corn oil). Repeated patch test for skin sensitization potency (occlusive method on 50 volunteers as is).

Evaluation of ingredient's behaviour in Environment after disposal

The aerobic biodegradation of test item was evaluated in an aqueous biodegradation test using sludge inoculum

without any pre-adaptation to the test item according to OECD 301 B (1992). The test was performed in duplicate and the incubation temperature was continuously kept at $21^{\circ}\text{C} \pm 1^{\circ}\text{C}$. The total test duration was 28 days. Reference (*Sodium Acetate*) and test item are added directly to the reactors. Each reactor is filled with the same amount of mineral medium and a precise amount of inoculum (containing micro-organisms from different wastewater treatment plants). When all reactors are filled, they are put on inductive stirrers and tubing is connected. A magnetic rod keeps the reference item, test item and the growing biomass into suspension throughout the test. The reactors are continuously aerated (with CO_2 free air) and incubated in the dark for 28 days. During the incubation CO_2 is produced and captured in KOH solution. At regular intervals the amount of CO_2 produced is determined by titration of the solution. The biodegradation based on CO_2 production is calculated as the percentage of solid carbon of the test compound which has been converted to gaseous, mineral C under the form of CO_2 . The test is considered valid if: (i) the total CO_2 production in the control reactors at the end of the test does not exceed 40 mg CO_2 /L medium. If values greater than 70 mg CO_2 /L are obtained, the data and experimental technique should be examined critically; (ii) the degree of biodegradation of the reference material is more than 60% after 14 days, and (iii) the difference in biodegradation between the test item replicates is less than 20% at the end of the test.

Assessment of versatility in formulation use

To evaluate the affinity in both water and oil phases, the ingredient has been added in different percentages (30%, 40% and 50%) to water/oil phases under stirring until the system has resulted homogeneous.

Evaluation of oil affinity

To evaluate the oil absorption capability, ISO 787/5-1980(E) standard has been taken as reference. Particularly known and growing amount of oils were slowly added and mixed with the powder until forming a paste of smooth consistency. This paste should just spread without cracking or crumbling and should only just adhere to the plate.

The procedure was repeated twice for each granulometry and with each different selected oil. In each trial, the oil amount used to form the paste corresponding to the description above was recorded.

Assessment of soft-focus effect

Placebo controlled clinical-instrumental evaluation to assess the soft-focus effect of five different face cream formulas in which different percentages and types of the examined ingredient have been added. In order to reach this goal, each product and a placebo formulation are applied by 20 healthy female subjects aged over 18 years old.

The assessment of product effect is carried out 15 minutes after their single application, by means of non-invasive bioengineering techniques able to quantify skin brightness/radiance. Moreover, the instrumental analysis is integrated by the clinical analysis carried out by a dermatologist. The skin radiance (or skin brightness), is the ability of the skin to reflect the light and it is measured using the gloss

parameter (taken using the spectrophotometer/colorimeter CM-700D Konica-Minolta) (Machková et al., 2018).

The instrument emits diffuse light that reaches the skin through an opening located at the extreme of the lighting sphere. A sensor located at 8° compared to the vertical axis of the opening detects then the reflected light and calculates a parameter known as "gloss". The gloss value is used in the management of the brilliance of the colour. Clinical evaluations are performed by the dermatologist according to the clinical scores: (1) not smooth skin, (2) little smooth skin, (3) smooth skin, (4) very smooth skin.

Statistical analysis

Data are submitted to two way test t of Student for paired data. Variations are considered statistically significant when p value is $\leq 0,05$.

Assessment of sensorial properties

To prove the comparable properties of tested item vs standard plastic microbeads, the ingredient has been included in skin care and color cosmetics finished products as substitute of exact % of standard microplastics (1:1). For every formulation, stability tests have been performed and the sensory profile has been defined through internal panel test on 20 volunteers. Main parameters of interest are: absorption, softening & smooth effect, greasiness & stickiness and film-forming skin feel.

RESULTS

The ingredient Celus-Bi® Feel is safe for cosmetic use.

It does not show a predictive cytotoxic / irritating potential and it is practically not irritating. Clinically tested not irritating and hypoallergenic (low sensitizing power).

Biodegradability of test item was compared versus Sodium Acetate, as reference item. The biodegradation of reference item started at a good rate. After 10 days it was already degraded by 64.9%. The biodegradation rate slowed down and at the end of the test (28 days) a plateau in biodegradation was reached at a level of $76.5\% \pm 8.8\%$.

The test is considered valid, if after 14 days the biodegradation percentage of the reference item is more than 60%. This requirement was clearly fulfilled.

The biodegradation of test item proceeded well throughout the test. After 10 days it was already degraded by 63.0%. The biodegradation rate gradually slowed down and at the end of the test (28 days) a plateau was reached at a level of $79.9\% \pm 2.4\%$. On a relative basis, compared to suitable reference substrate sodium acetate, a biodegradation percentage of 104.4% was calculated. As the difference in biodegradation between the tested item replicates is less than 20% at the end of the test, the test can be considered valid. According to the OECD Guideline for Testing of Chemicals 301 B – CO_2 Evolution Test (1992) a biodegradation of more than 60% should be reached within 28 days of testing.

From these results it can be concluded that test item fulfilled the requirement for chemicals. Moreover, the requirement for ready biodegradability was also fulfilled, since the 10% to 60% pass level was achieved within a 10-day window. Biodegradability behavior is shown in Figure 1.

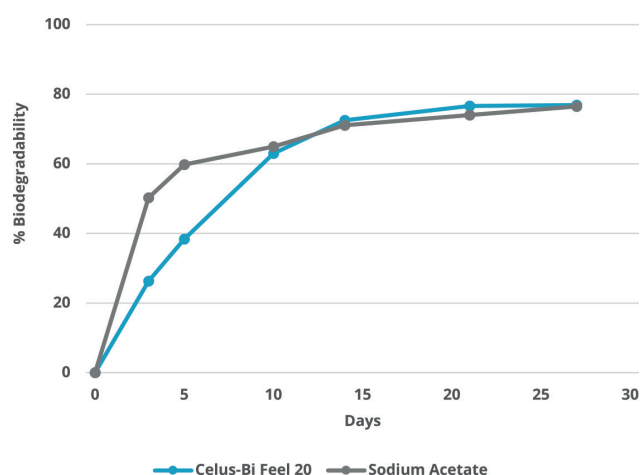


Figure 1. Biodegradability.

Celus-Bi® Feel perfect balance between hydrophilic and hydrophobic behavior, make the test item ideal and useful for both oil and water phase. Thanks to this property, during the emulsion realization, it can be easily dispersed both in water and oil phase. It can be also inserted at the end of formulation. Visual experiments are shown in Figure 2.

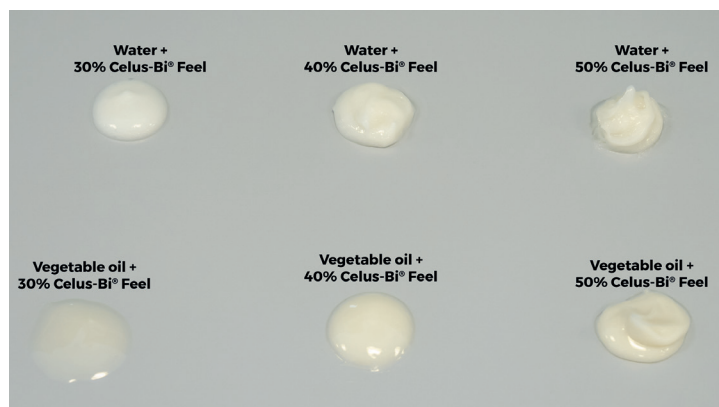


Figure 2. Double versatility.

OIL	POLARITY INDEX	CELUS-BI® FEEL 5 (mL/100gr)	CELUS-BI® FEEL 10 (mL/100gr)	CELUS-BI® FEEL 20 (mL/100gr)
Refined linseed oil	low	130	125	130
Persea gratissima oil	low	130	115	107.5
Ricinus communis oil	low	160	130	115
Caprylic/Capric Triglycerides	medium	125	150	115
C12-C15 Alkyl Benzoate	medium	120	112.5	107.5
Octyl Palmitate	medium	130	125	115
Octyldodecanol	medium	125	125	145
Coco Caprylate/Caprate	medium	135	132.5	107.5
Dimethicone	medium	160	172,5	135
Isopropyl Palmitate	medium	125	132,5	110
Dicapryl ether	high	135	140	115
Octyl stearate	high	145	110	110
Paraffinum liquidum	high	140	120	120
Water	high	225	235	225
Olive Glycerides	high	125	112.5	115
Tripelargonin	medium	120	117.5	125
Neopentyl Glycol Dipelargonate	medium	140	150	115
Pentaerythryl Tetrapelargonate	high	150	140	125

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Table reporting the amount of oil (expressed as ml) for 100 g of powder. Results confirmed the good ability of Tested item in incorporating oil ingredients, when used in oil phase. Data are reported shown in Table 1.

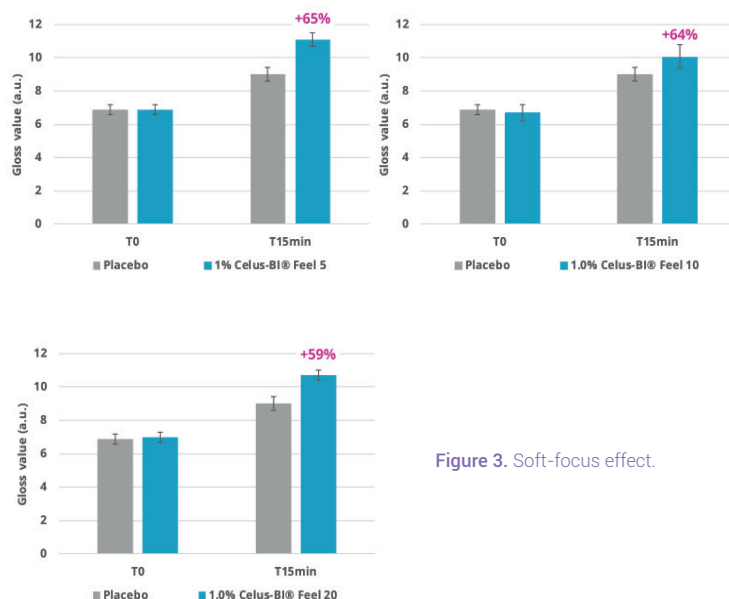


Figure 3. Soft-focus effect.

Tested item determines a statistical improvement of skin radiance / brightness both compared to baseline and to placebo as shown in Figure 3.

Tested item applied in skin care and color cosmetics formulas proves to have a performance in line and in some cases even better than benchmarks. Data not shown.

DISCUSSION

Focusing on the results shown above, tested item, included in different formulations in ratio 1:1, demonstrated to have a similar or improving performance, in terms of soft focus, oils absorption, sebum control and texturizing properties, compared to standard microplastics.

Tested item is an excellence because it is composed of vegetable derived substances such as *cornstarch* and *glycerin*, and synthetic raw materials as PVA. This advanced cutting edge technological powder results in an ingredient that is performing and biodegradable.

CONCLUSIONS

Tested item (Celus-Bi® Feel) is sustainable thanks to its performing activities in personal care

formulations with a low impact on Environment. As valid alternative to microplastics used in leave-on cosmetics, it can replace several technological and sensorial profiles of different standard powders, thanks to its versatility in different formulas. It is the ready-to-use innovation that can easily be formulated in leave-on cosmetics, giving the chance of a sustainable claim, with the same high profile performances of standard ingredients.

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ABOUT THE AUTHOR

Alessandra Adduci is graduated in Pharmaceutical Chemistry and Technology from University of Milan in Italy, with experience as researcher in cardiovascular unit at IRCCS Mario Negri Institute for

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CELUS-BI® FEEL

DO NOT TOUCH FOOD FOR BEAUTY

PRACTICING SUSTAINABILITY IN EVERYDAY LIFE

Performing alternative to standard plastic microbeads in leave-on cosmetics.
Ethical sourcing based on **no food competition**.

ROELMI HPC has developed **Celus-Bi® Feel**, the next generation of biodegradable sensorial agents with multiple actions (texturizing, formula touch & stability, soft focus and many others).



Tested performances,
alternative to plastic microbeads



Safe for Nature,
it does not interfere with Food sources



Safe for People,
ethical & sustainable choice

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