



Microalgae: biological activities for cosmetics

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'Conference and Exhibition for the Sustainable Aquaculture and Fishing Industry. Focus also on algae cultivation and vertical farming'
Pordenone 26-27 gennaio 2017

European cosmetics market

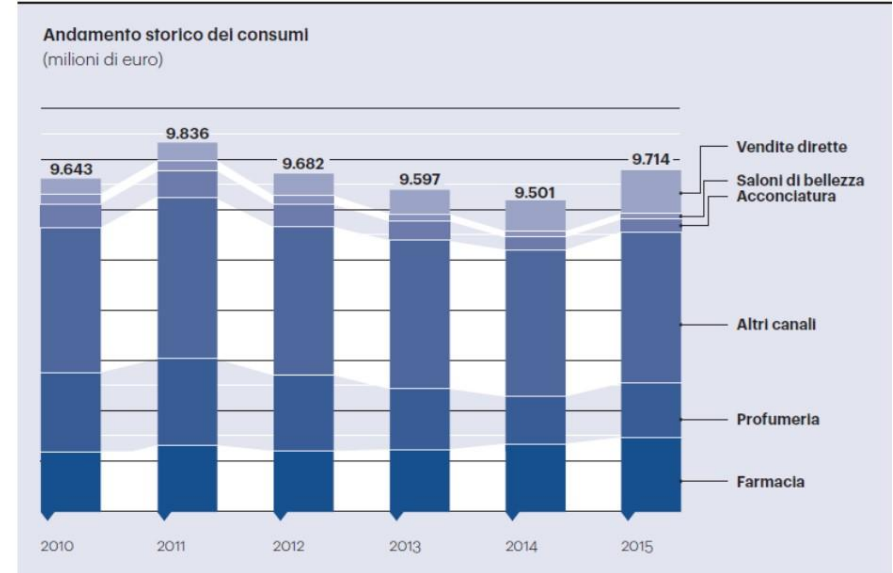
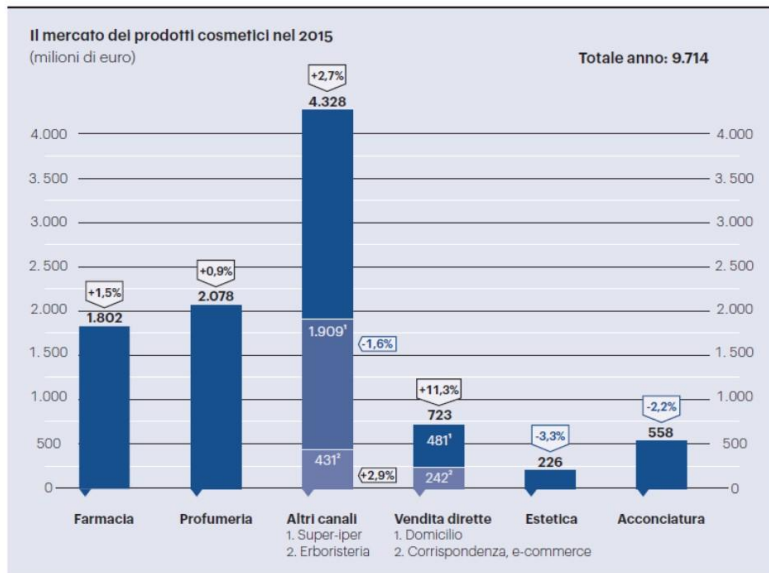
GLOBAL MARKET FOR COSMETICS PRODUCTS
(€ BILLION) (COSMETICS EUROPE, 2015)



EUROPEAN MARKET FOR COSMETIC PRODUCTS
(RSP BASIS, € BILLION)



In Italy



FUNCTIONS OF COSMETIC PRODUCT

TOILET FUNCTION

It aims to remove dirt from the surface of the skin respecting the physiological characteristics (Cleaning, Deodoration).

EUTROPHIC FUNCTION

supports the state of the tissues, on which the cosmetics are applied under the best conditions. Cosmetic eutrophic: it maintains proper skin tropism generating substances that support normal physiological events that occur in a healthy skin (Protection, Normalisation)

COSMETIC FUNCTION

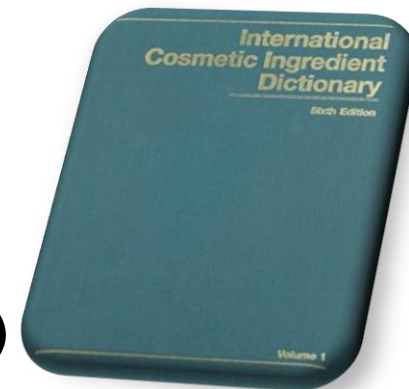
It aims to positively influence the sensory functions of sight and smell. And 'the link of hygiene- circle health- beauty (Decoration, Treatments, Scent)





Reference books on cosmetic commodities

- **International Cosmetic Ingredient Dictionary**
Cosmetic, Toiletry and Fragrance Association -
USA (Personal Care Products Council) XVI Ed, 2016
- **European Inventory of Cosmetic Ingredients (2006)**



INCI USA e INCI EU



the same with some exceptions

Dyes – similar names to FDA in USA, Colour Index in EU
Eg. Blue 1 (USA), CI 42090 (EU)

Vegetable extracts – In USA It is most often used English common name, in EU botanical name, eg. Shea Butter (USA), *Butyrospermum parkii* Butter (EU)

Some conventional products, eg. Beeswax (USA), Cera alba (EU)

Cosmetic Ingredients classification

Lipids, Emulsifiers, surfactants, solubilizing, rheology modifiers, Matting / pearling for tensiolitics, Preservatives and antimicrobial skin, sequestering, antioxidant, Humectants, coloring matter, conditioning, Film-forming and fixatives, texturizers, solvents, propellants, silicone, Flavor and fragrance, functional ingredients



Microalgae: which opportunities

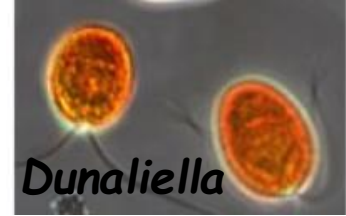
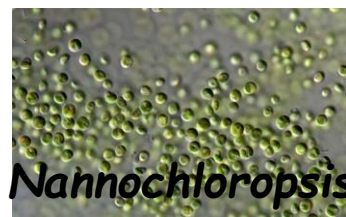
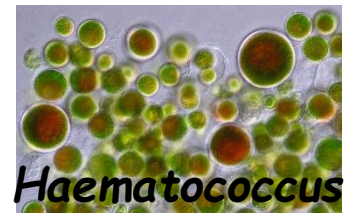
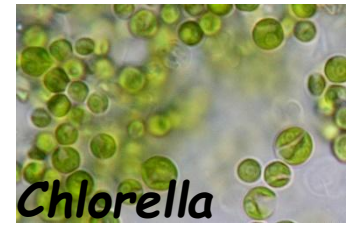
- Thousands of species that can be screened for the different needs
- Flexible metabolism that can be addressed towards the production of lipid, proteins or phytochemicals
- Advantages and disadvantages compared to terrestrial plants

Microalgae in Personal Care Products

Body and face Care, Scrubs, Masks, Creams, Cleansers, Shampoos,

European Commission database for information on cosmetic substances and ingredients

Haematococcus pluvialis EXTRACT as **antioxidant**
Chlorella EXTRACT as **skin conditioning**
Spirulina maxima EXTRACT as **smoothing**
Porphyridium cruentum EXTRACT as **skin conditioning**





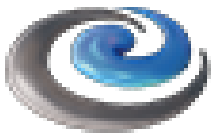
MicroLife. A better life.

INNOVAZIONE EVENTI CONFERENZE



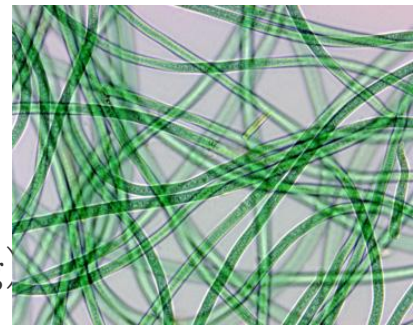
News

Maschera Viso alle Microalghe

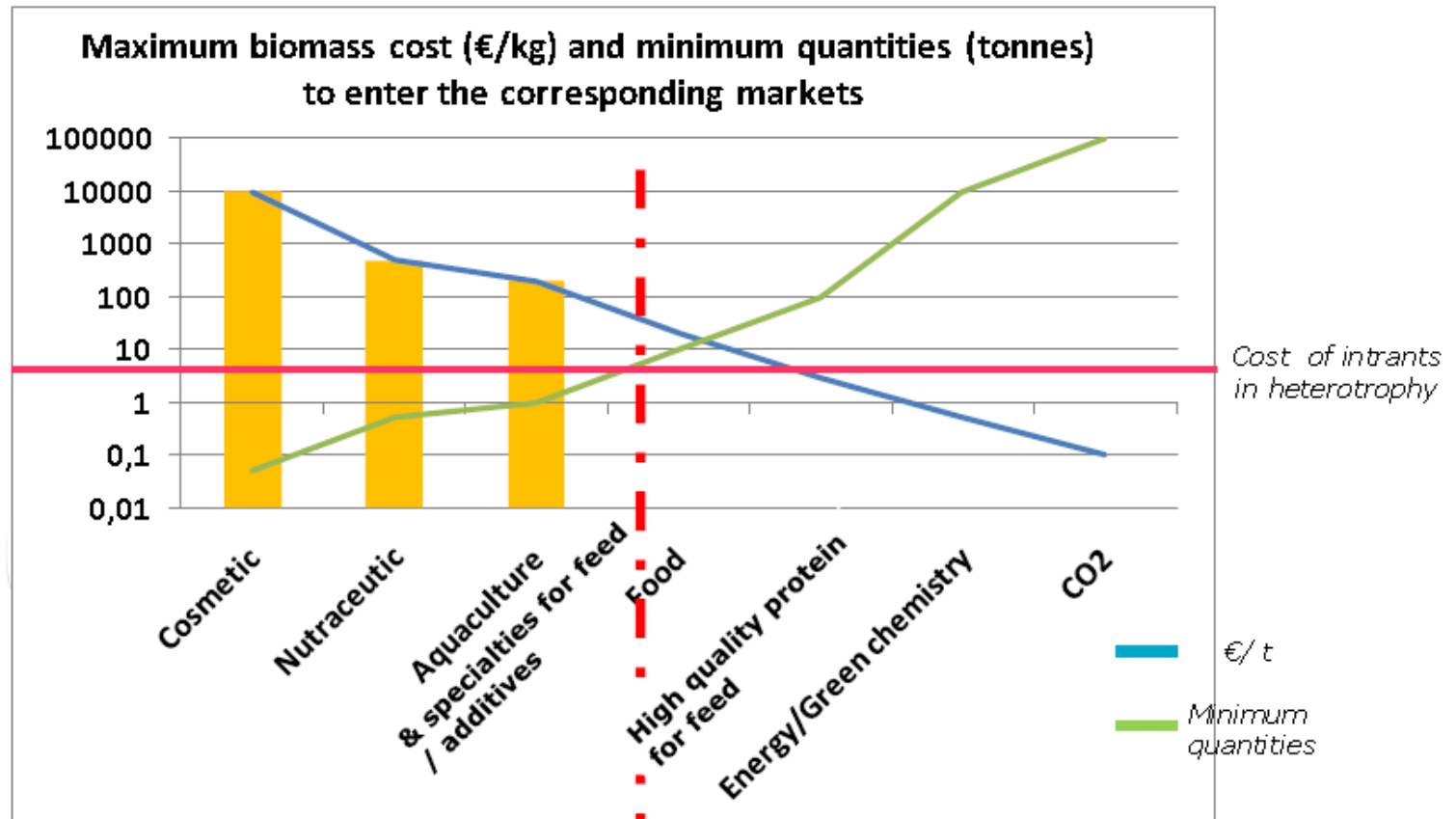


THERMAE ABANO MONTEGROTTO

Phormidium e il ceppo ETS-05 (da Euganean Thermal Spring)



Microalgae and market access



Existing opportunities

The future to Shape

Estimated world microalgae production: 15.000-20.000 tonn

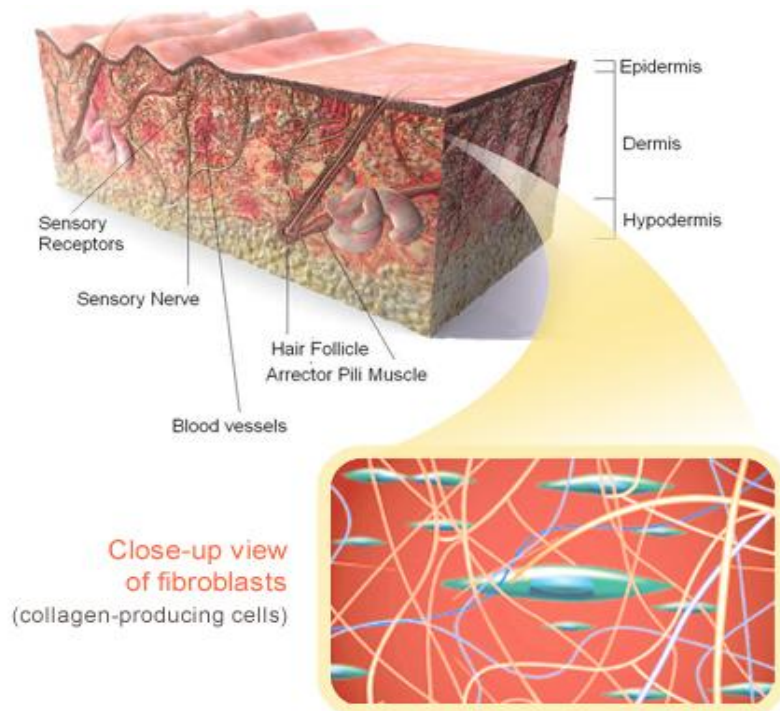


NICHE MARKET – HIGH COST

Biological activities of cosmetic interests

Studies based on cell biology using reliable in vitro assays and suitable cell lines are required.

The effect of putatively active algae extracts should be tested on:

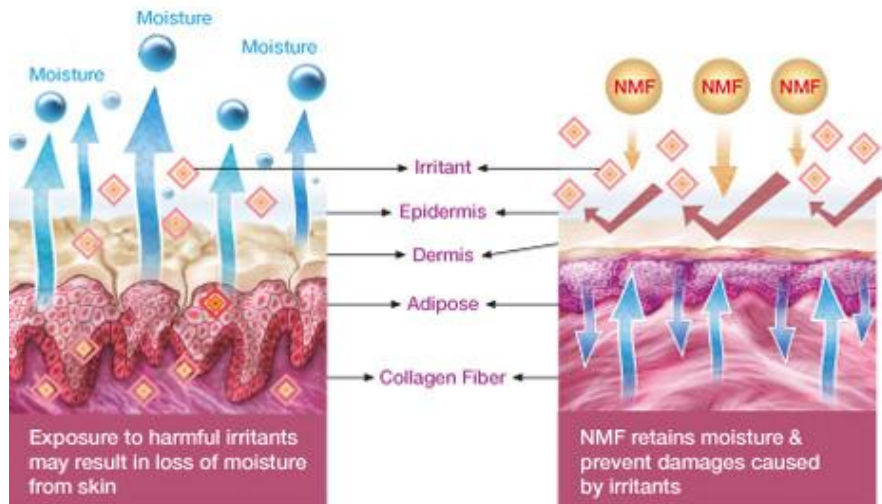
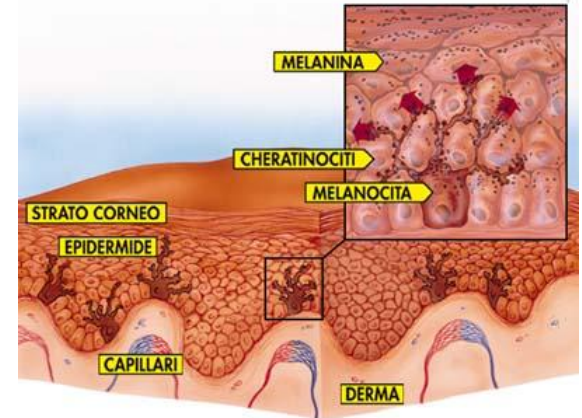


- Metabolic pathways which are known to interfere with the health of skin tissue
- Expression of genes and activity of proteins correlated to this pathways



Skin cell biology: cell lines

- ❖ Keratinocytes (HaCaT)
- ❖ Murine Fibroblasts (NIH 3T3)
- ❖ Human Dermal Fibroblasts (primary cells)
- ❖ Melanocytes (B16F1)
- ❖ Adipocytes precursors (hMSC)
- ❖ Differentiated Adipocytes

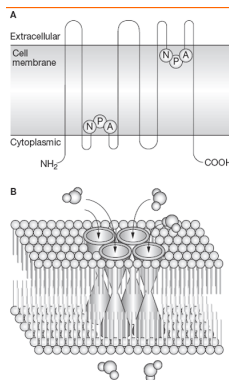


Assay conditions

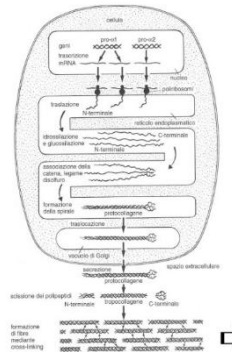
- **Oxidative Stress**
- **UV Radiations**
- **Heavy Metals Stress**

Skin Cell Biology: cell-based Assays

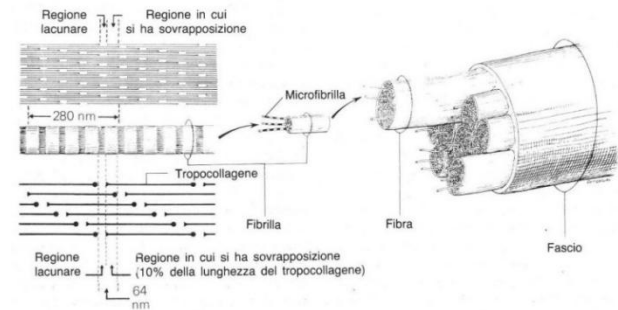
- Collagen synthesis & degradation (Coll, Col III MMP's)
- Hydration capacity (Aquaporin3, Filagrin, Involucrin)
- Anti-inflammation assay (NO radical, COX2 iNOS)
- DNA repair and longevity (Comet Assay, SIRT1 expression and activity)
- Heavy Metal protection (Heat shock proteins - hsp70)
- Repulping, anti-cellulite, anti-fat (cAMP, Lipase activity, Adipocyte formation)
- Skin rejuvenating activity (mesenchymal stem cell differentiation assay; Fibroblast and keratinocyte induction)



Struttura delle acquaporine



Sintesi e struttura del collagene



Biological activities of dermatological interest by the water extract of the microalga *Botryococcus braunii*

Silvia Buono · Antonio Luca Langellotti · Anna Martello ·
Marida Bimonte · Annalisa Tito · Antonietta Carola ·
Fabio Apone · Gabriella Colucci · Vincenzo Fogliano

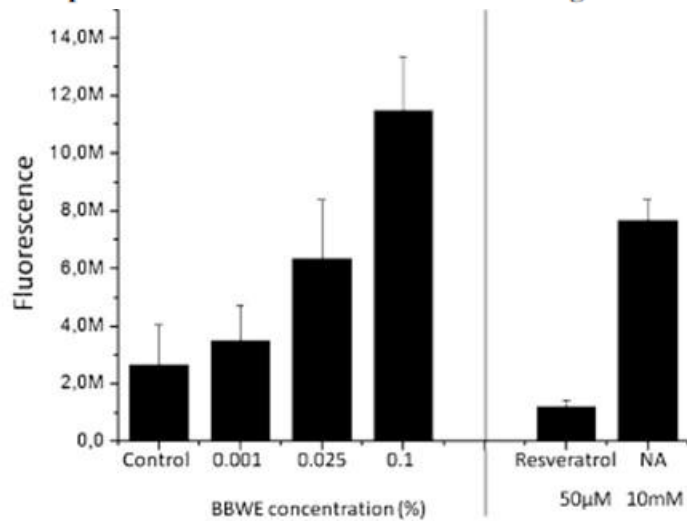


Fig. 1 Adipocyte differentiation assay. Fluorescence measured on human mesenchymal stem cells differentiated in adipocytes treated with BBWE at different concentrations and with nicotinamide (NA positive control) and resveratrol (negative control)

At concentrations ranging from 0.1 to 0.001 % (w/v) BBWE promoted adipocytes differentiation by inhibiting hormonesensitive lipase, thus promoting triglyceride accumulation in the cells.

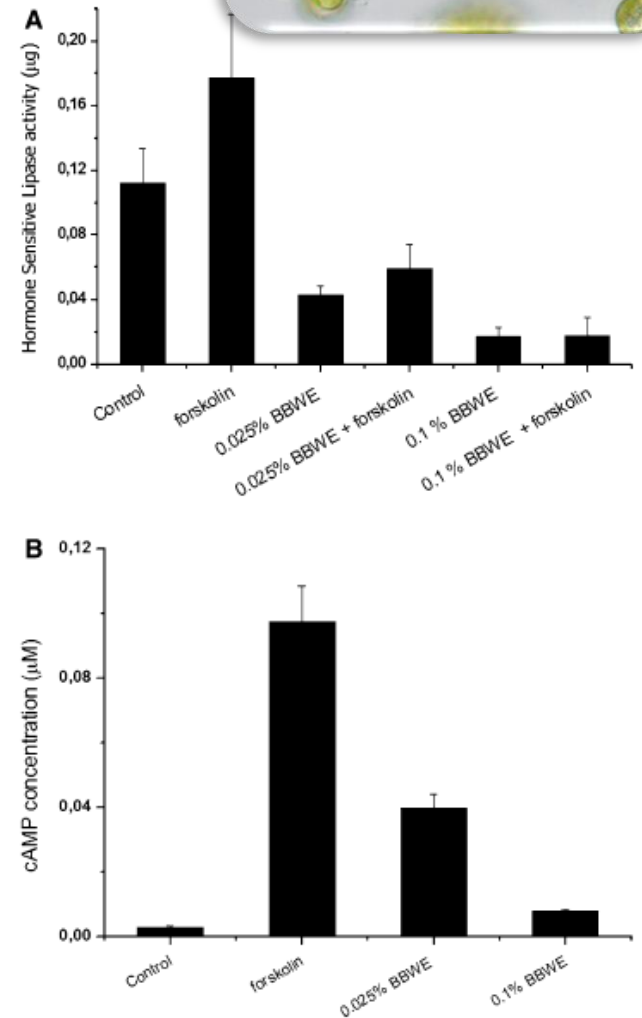
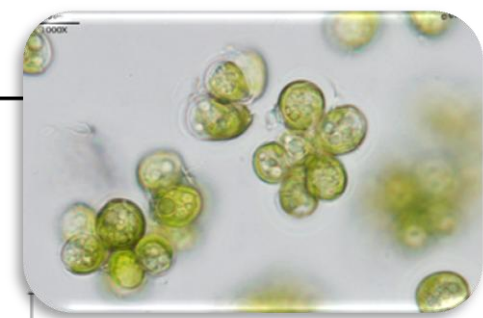


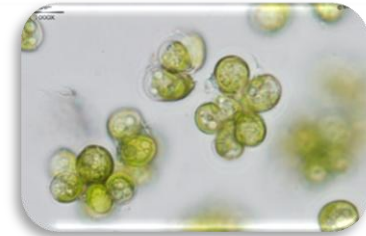
Fig. 2 a Effect of BBWE of hormone lipase activity in combination with forskolin (5 µM), a well-known activator of the adenylate cyclase. b Effect of BBWE in combination with forskolin (5 µM) on cAMP concentrations measured in adipocytes



Effects of BBWE at different concentrations on the synthesis of collagen, expression of genes related to cell hydration, production of reactive oxygen species

Synthesis of collagen type I and type III (control was set as 100 %). NIH3T3 cells were treated with BBWE (range from 0.001 to 0.1 %). Ascorbate was used as positive control

	I Collagen production (% ± SD)	III Collagen production (% ± SD)
BBWE 0.001 %	131.5 ± 3.2	120.9 ± 15.1
BBWE 0.01 %	137.1 ± 13.2	119.7 ± 20.5
BBWE 0.03 %	159.4 ± 18.9	122.6 ± 17.6
BBWE 0.1 %	180.6 ± 2.1	143.5 ± 15.1
Ascorbate 300 μM	166.9 ± 20.3	154.2 ± 18.3

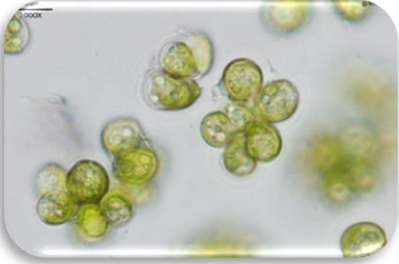


Expression of AQP3, FLG and INV genes (control was set as 100 %). Human keratinocytes (HaCaT) treated with BBWE at different concentrations

	AQP3 (% ± SD)	FLG (% ± SD)	INV (% ± SD)
BBWE 0.001 %	133 ± 6	122 ± 3	171 ± 8
BBWE 0.05 %	242 ± 10	139 ± 5	175 ± 7
BBWE 0.1 %	266 ± 9	149 ± 5	188 ± 8

ROS production (control was set as 100 %) measured on NIH3T3 treated with BBWE at different concentrations. No stress and stress (H₂O₂ 150 μM treatment) conditions are shown

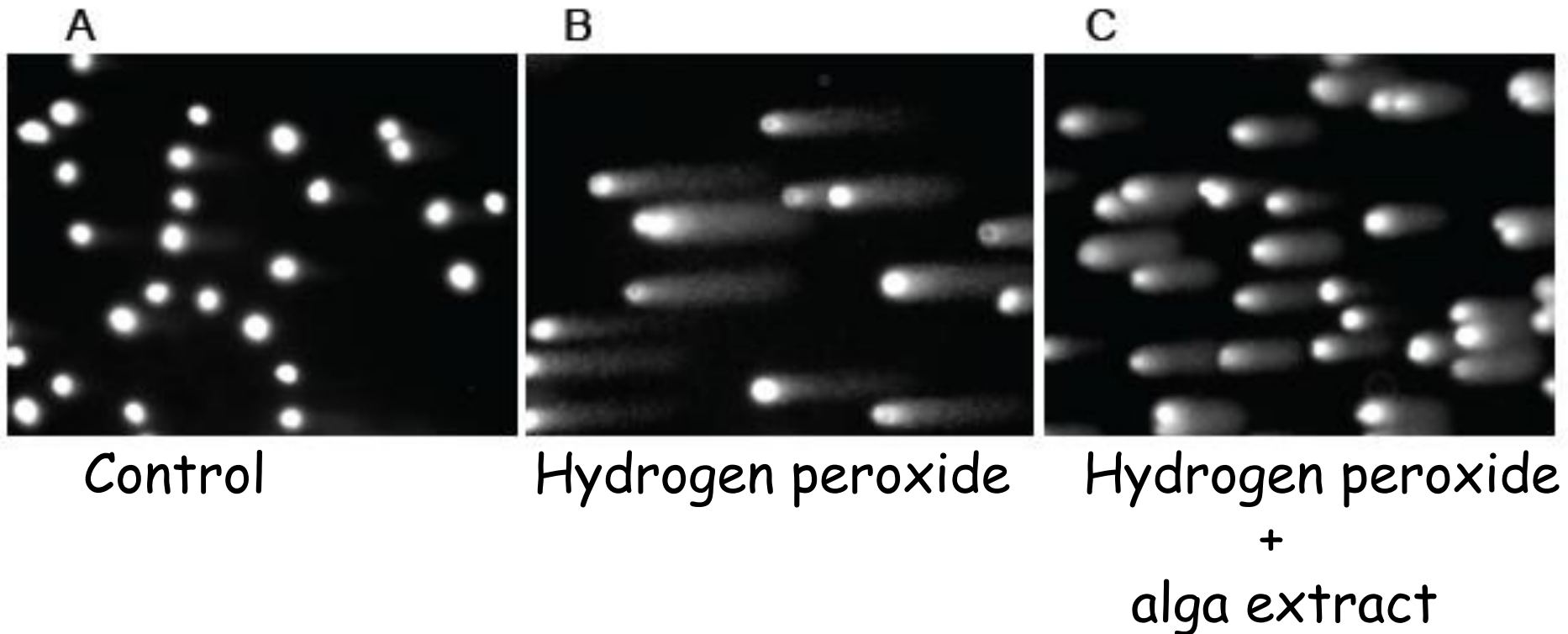
	ROS production (% ± SD) No stress	ROS production (% ± SD) H ₂ O ₂ (150 μM)
Control	100 ± 20.1	794.7 ± 71.3
BBWE (0.05 %)	97.6 ± 64.3	521.7 ± 75.4
BBWE (0.1 %)	98.6 ± 13.9	489.7 ± 66.4
Ascorbate (250 μM)	94.8 ± 8.0	289.4 ± 25.6



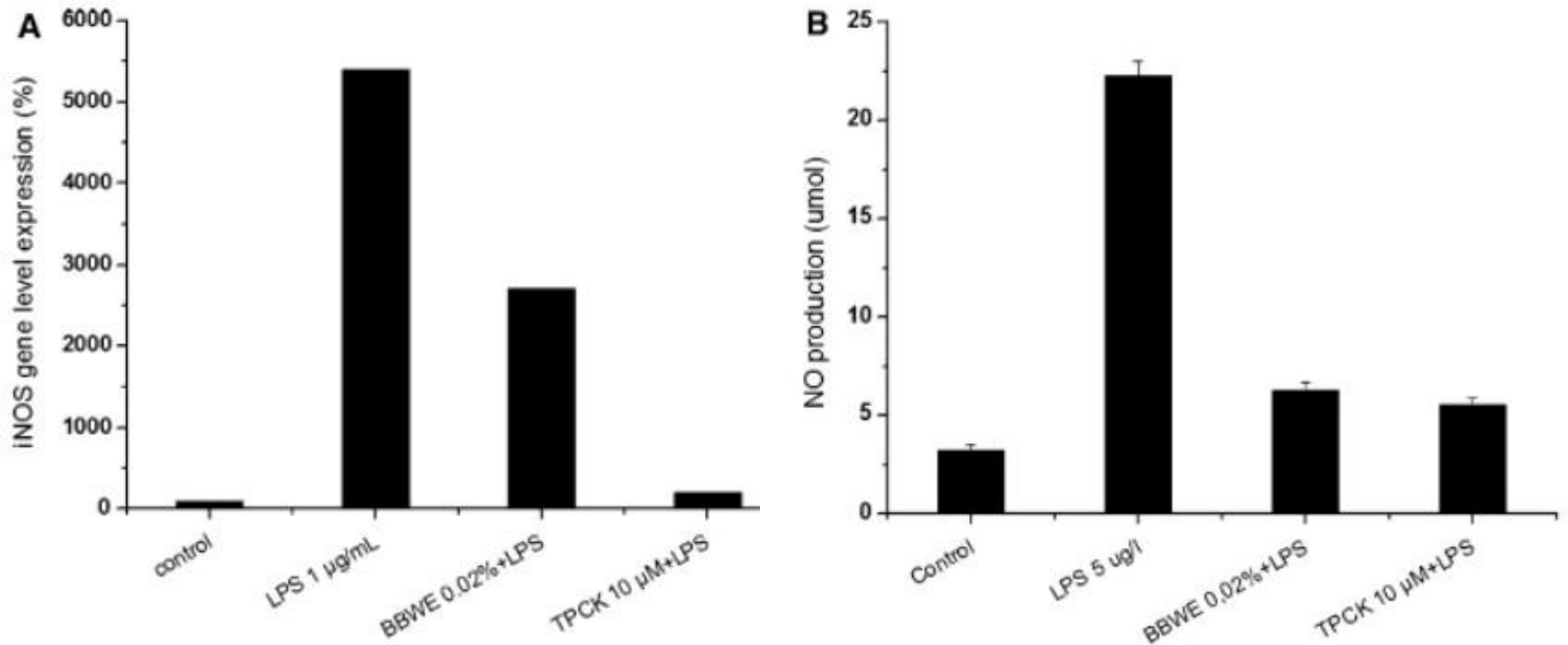
DNA damage - COMET assay

Length wake of cellular nucleus ($\mu\text{m} \pm \text{SD}$) measured for each treatment (control, H_2O_2 , *B. braunii* extract 0.02–0.1 % in the presence of H_2O_2)

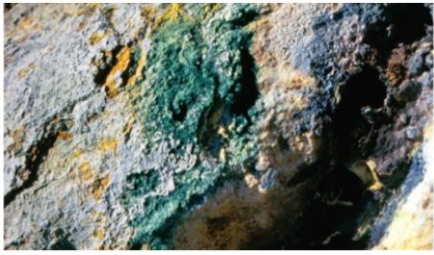
	Tail length ($\pm\text{SD}$)
Control	1.4 ± 1.0
H_2O_2 (175 μM)	25.0 ± 4.5
BBWE (0.02 %) + H_2O_2	21.8 ± 5.0
BBWE (0.1 %) + H_2O_2	18.7 ± 3.5



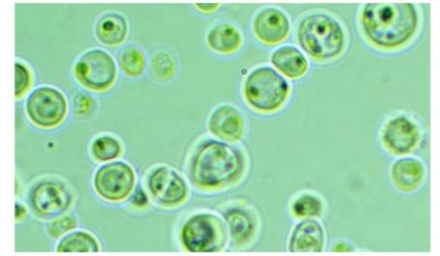
BBWE inhibited the inducible nitric oxide synthase (iNOS) gene expression and the consequent nitrite oxide (NO) production under oxidative stress.



At a concentration of 0.02 % BBWE reduced by 50 % the expression of iNOS and by about 75 % the NO production.



Ministero dello Sviluppo Economico
Ufficio Italiano Brevetti e Marchi



Patent

cosmetic compositions containing extracts derived from microalgae *Galdieria sulphuraria*, particularly suitable to reduce the harmful effects caused by acne

TRICHOLOGY AND COSMETOLOGY

Openventio
PUBLISHERS

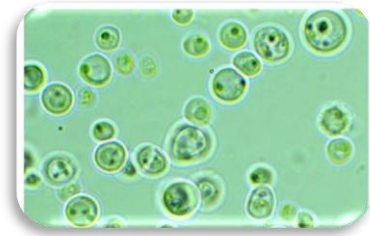
Open Journal 

<http://dx.doi.org/10.17140/TCOJ-1-103>

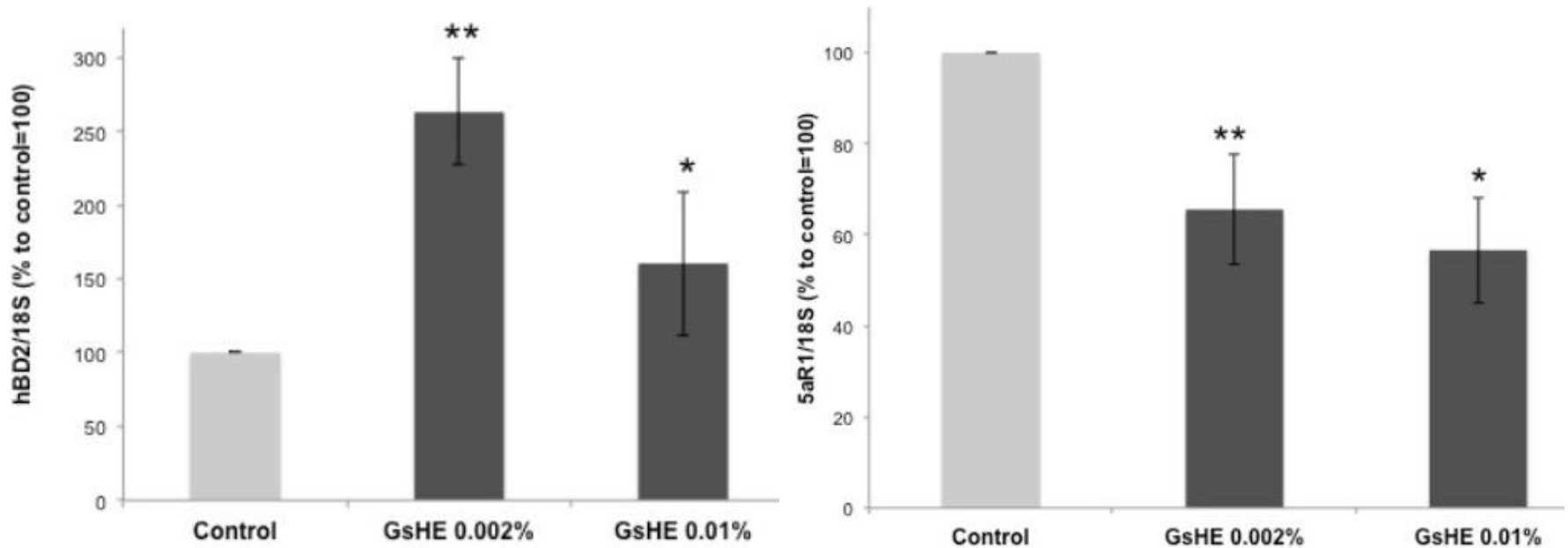
Galdieria sulphuraria Relieves Oily and
Seborrheic Skin By Inhibiting the 5- α
Reductase Expression in Skin Cells and
Reducing Sebum Production *In Vivo*

M. Bimonte, PhD¹; A. De Lucia, PhD¹; A. Carola, PhD¹; A. Tito, PhD¹; S. Buono, PhD²; A.
L. Langellotti, PhD²; V. Fogliano, PhD³; G. Colucci, PhD⁴; Fabio Apone, PhD⁴

Results



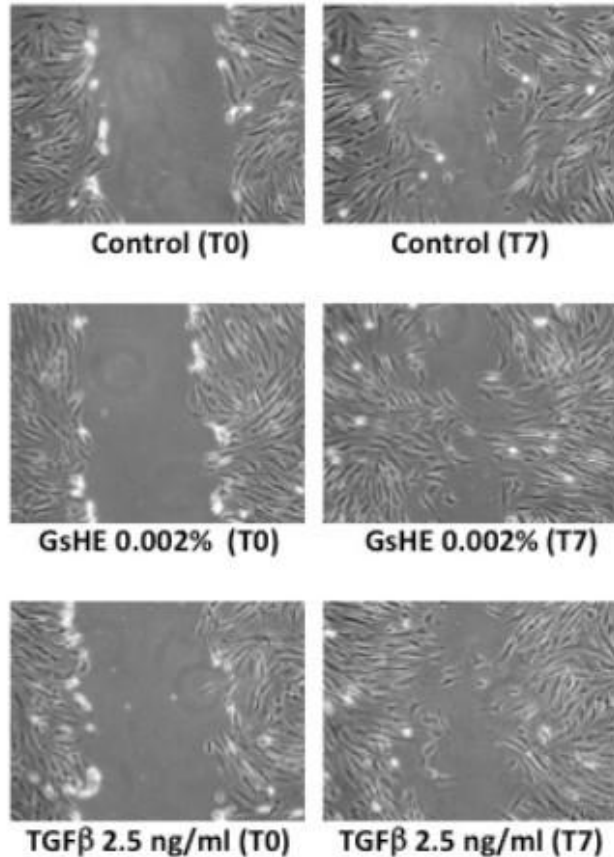
From the extremophile microalga *G. sulphuraria* the water-soluble extract was capable of inhibiting the enzyme 5- α Reductase, inducing the expression of the β -defensins.



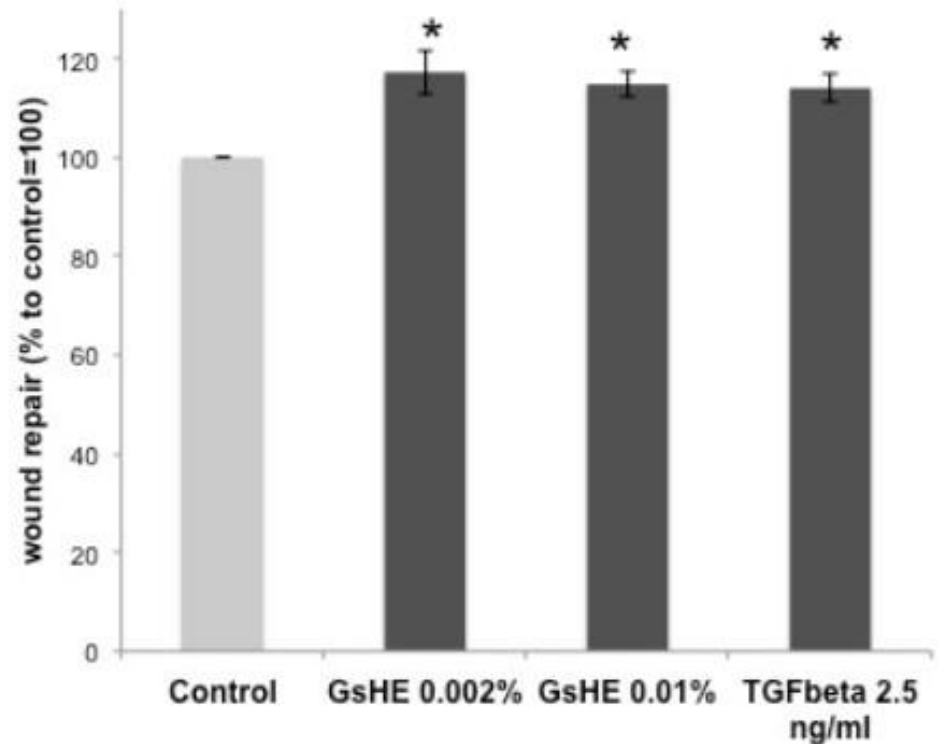
Results

GsHE increased the capacity of the cells to repair the wound: it accelerated the cell migration and the healing process by 17% at the concentration of 0.002%, compared to the untreated control, similarly to the Transforming Growth Factor- β (TGF- β), known for its ability to accelerate the wound repair.

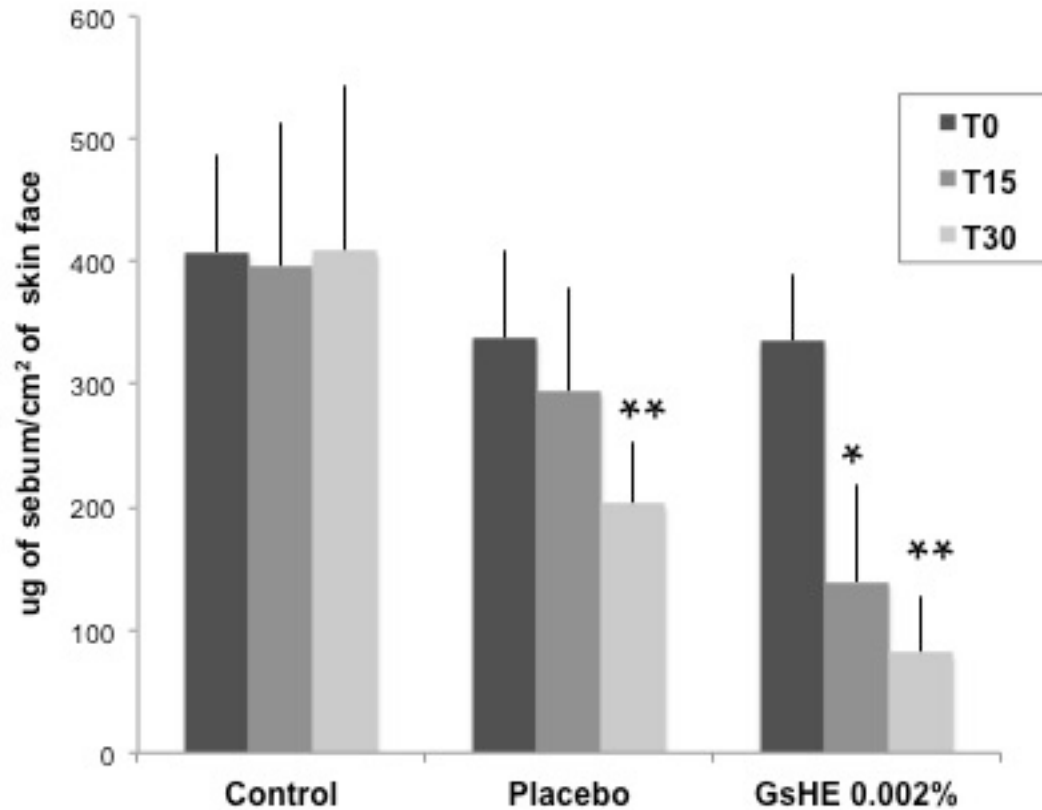
A



B



Clinical test - Results



Cream without the active (placebo);

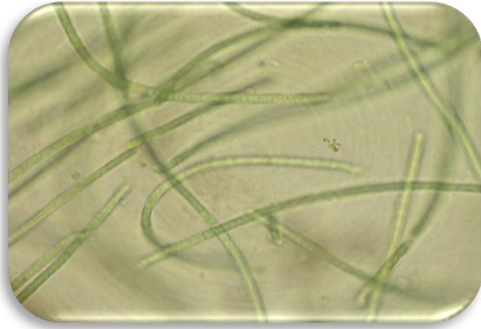
Cream containing GsHE (0.002%);

Untreated skins (Control).

Treatment: twice a day for 28 consecutive days.

The sebum level on the skin was measured by the instrument Sebumeter® SM815.

Cyanobacterium unknown from Ischia island: *Phormidium*-like

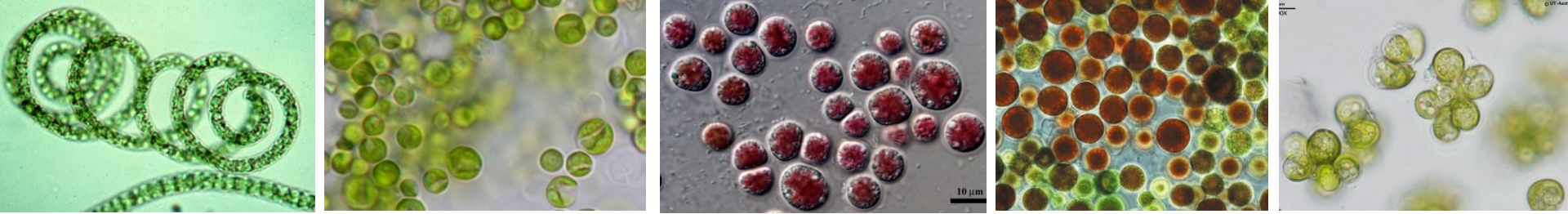


Isolated from a thermal pond in **Ischia** island. It grows in alkaline waters and at high temperature (60 -70 °C)



Hydrosoluble extract was effective in inducing the formation of the skin hydro-lipidic layer (hydration and water retention), inhibiting pro-inflammatory cytokinin production (anti-inflammation), inducing Kallikrein synthesis (exfoliation).

	Hydration		Anti-Inflammation			Exfoliation
	GBA	SMPD1	IL1 alpha	IL1 beta	IL8	KLK5
0.000032 %	24%	38%	-	-	-	33%
0.00016 %	36%	76%	-35%	-34%	-28%	51%
	HaCat		HaCat			NHEK



Conclusion

- Microalgae has great potentiality in cosmetics (largely unexplored)
- Well designed experiments allows to define the specific activity for each algae-based bioactive preparations
- Beside in vitro and cells assay there is a need of tools to assess activities on tissue (artificial skin)



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Industry - Aquaculture Centre

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Fabio Apone
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Luigi Sena

*Thank you for
your attention*

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